RC REID

YS-11

TRAINING GUIDE

FOR MAINTENANCE COURSE

VOL. I

SERVICE DEPARTMENT

NIHON AEROPLANE MANUFACTURING CO.,LTD

INTRODUCTION

This Training Guide has been prepared as an educational material to be used to familiarize mechanics with Japanese medium transport YS-11A.

This Guide deals with the generalities of the outline, composition and function of each system but does not give the actual job description such as removal or installation procedures of functional units or interior mechanism and function in details.

Consequently, if such information is needed, the operator is requested to refer to the various YS-11 manuals.

Therefore, this Training Guide only serves as a guide for the various YS-11 manuals and it should be noted that it does not deal with the details necessary for actual work practices.

This Training Guide should not be used by the operator for their operation or maintenance.

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First Issue: June 30/67
Revision: December 15/67

TRAINING GUIDE

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Chapter 1 INTRODUCTION

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Chapter 1 INTRODUCTION

1.1 General

The YS-11 is an all metal, low wing, monoplane with a wing and tail of cantilever, stressed skin construction and a fuselage with circular section of stressed skin construction.

In the L.H. and R.H. wing nacelles are installed 2 Rolls Royce Dart Mark 542-10 turboprop engines.

1.2 Summary

Structurally the fuselage consists of 3 parts; forward, center and aft sections.

The fuselage is pressurized all the time during flight and at 20,000 ft of flight altitude, the cabin altitude is maintained at 8,000 ft.

The fuselage is divided into 2 parts; the above-floor space and the under-floor space by aluminum honeycomb floor. Above the floor are located the cockpit, cabin, galley, toilet and cargo compartment. The space below the floor is occupied by the nose gear compartment, electrical compartment, belly cargo compartment, flight control compartment, hydraulic compartment and air conditioning compartment.

The crew consists of 5, the pilot, copilot, observer and 2 stewardesses and the cabin arrangement provides 60 passenger seats.

The wing consists of the center wing and the L.H. and R.H outer wings, the former being joined to the center fuselage permanently and the latter joined to the center wing with bolts.

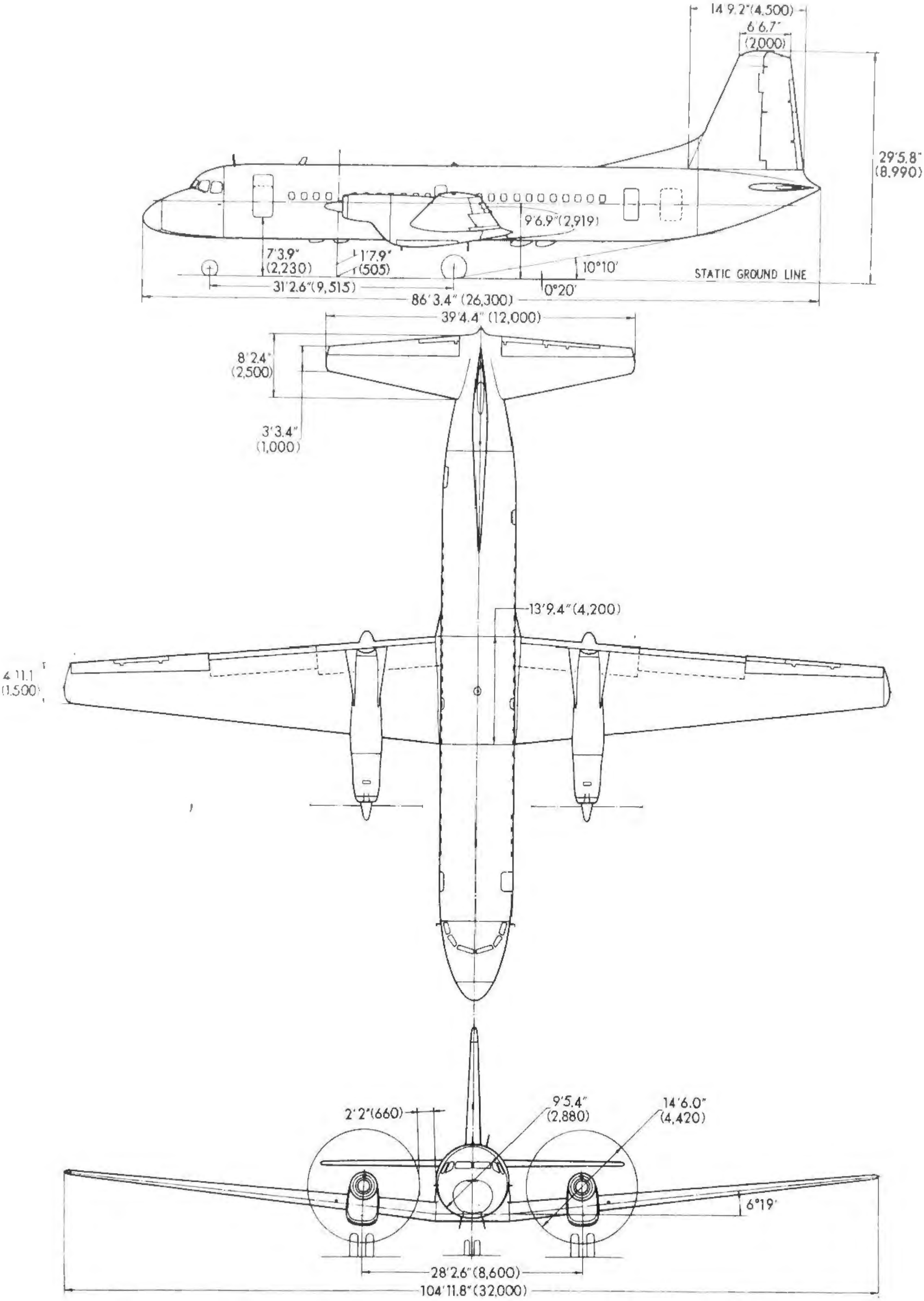
Outboard the nacelle, between the spars in the outer wing is located the integral fuel tank and inboard the nacelle are the water methanol bag tank and the fuel bag tank.

The landing gear mechanism is of nose gear type, fully retractable with the nose gear hydraulically steerable and the main gear with the anti-skid mechanism.

The 3 flight control surfaces are manually controlled by the pilot or the copilot.

The flap is of Fowler type, actuated by a hydraulic motor through a torque tube.

The engines and the propellers are electrically deiced and deicers of rubber boots type are installed on the leading edges of the wing and the tail.



YS-11 Three View

Figure 1—1

The hydraulic pressure of 3,000 psi is used to actuate the landing gear, brake steering etc. As for fire extinguishing device, fire in each engine, deicing heater, landing gear bay or nacelle can be extinguished separately.

The electronic equipment includes communication units such as HF and VHF and navigation units such as VOR, LOC, G/S, Marker etc. Provision is also made for installing the weather radar and auto-pilot mechanism.

DC, constant frequency AC and wild frequency AC power sources are utilized to activate the above-mentioned systems.

1.3 Operation

The YS-11 can be operated within the operating temperature limitation; -50°C to ISA + 30°C of the outside air temperature except the following:

1. Water methanol injection permissible	above -20°C.
2. External power starting permissible	above -30°C.
3. Internal power starting permissible	above -10°C.

1.4 Leading Particulars

1.4.1 Weights

The breakdown of the take-off gross weight under a typical loading condition is given below:

		LB (Kg)	LB (Kg)
Weight Empty			31,970 (14,500)
Additional Equipment			550 (249)
Crew	Pilots (2)	340 (154)	
	Stewardesses (2)	260 (118)	
	Baggage	60 (27)	
		660 (299)	660 (299)
Operational Weight			33,180 (15,050)
Payload			15,320 (6,950)
	Passengers (160x60)	9,000 (4,080)	
	Cargo	4,300 (1,945)	
	Additional Load	2,020 (925)	
		15,320 (6,950)	
Zero Fuel Weight			48,500 (22,000)
Oil			84 (38)
Fuel			4,875 (2,212)
Water Methanol			551 (250)
Take-off Weight			54,010 (24,500)

1.4.2 Breakdown of Empty Weight (Reference to Your Type Spec)

The calculated breakdown of the empty weight is given below(at YS-11):

	LB(Kg)
Airframe Structure	
Wing	6,618 (3,002)
Tail	1,465 (664)
Fuselage	5,525 (2,506)
Landing Gear	2,110 (957)
Nacelles	1,541 (699)
Total	17,257 (7,828)
Power Plant	6,184 (2,805)
Basic Equipment	
Instrument System	205 (93)
Flight Control System	719 (326)
Hydraulic System	602 (273)
Electrical System	1,863 (845)
Electronic System	1,039 (472)
Interior Equipment	3,029 (1,374)
Air Conditioning System	776 (352)
Deicing System	357 (162)
Oxygen System	31 (14)
Fire Extinguishing System	97 (44)
Stairway	315 (143)
Total	9,033 (4,098)
Miscellaneous	
Paint and Exterior Marking	77 (35)
Undrainable Oil	40 (18)
Unusable Fuel	220 (98)
Total	337 (151)
Empty Weight	32,811(14,882)

1.4.3 Operating Limitations

Weight Limitation	YS-11	YS-11A
Maximum Take-off Weight	51,800(23,500)	54,010(24,500)
Maximum Landing Weight	49,600(22,500)	52,910(24,000)
Maximum Zero Fuel Weight	45,640(20,700)	48,500(22,000)

C.G. Limitation
With flap 0° and landing gear down

Weight LB(Kg)	Most Forward % MAC	Most Rearward % MAC
35,270 (16,000)	15	36
54,010 (24,500)	22.4	36

1.4.4 Speed Limitation

				KT
Maximum Operating Limitation	below 13,600 ft		V_{mo}	[illegible]
	above 13,600 ft		M_{mo}	0.475
Operating Speed			V_A	[illegible]
Flap Extended Speed	Flap angle less than 10°		V_{fe}	[illegible]
	Flap angle less than 20°			165
	Flap angle less than 35°			[illegible]
Landing Gear Operating Speed		Down	V_{LO}	[illegible]
		Up		[illegible]
Landing Gear Extended Speed			V_{LE}	[illegible]
Landing Light Extended Speed				165

1.4.5 Towing Load

The supporting structure of each main landing gear has been designed for the limit towing load of 8,294 lbs (3,762 Kg).

1.4.6 Jacking Load

The structures around the jacking points have been designed to be able to support the aircraft weight of 54,010 lbs (24,500 Kg).

1.4.7 Cabin Pressure Load

Each section of the pressurized fuselage has been designed for the normal operating pressure of 4.16 psi which corresponds to the cabin altitude of 8,000 ft at the flight altitude of 20,000 ft.

1.4.8 Floor Loading and Allowable Weight of Passengers and Cargo Loading of Fuselage Floor

Item		Floor Loading lbs/ft^2 (Kg/m^2)	Allowable Cargo Weights lbs (Kg)
Cabin	75 (366)	75 (366)	
Forward Cargo Comp't (RH)	52 seats 38" pitch	100 (488)	1,500 (681)
	52 seats 34" pitch		2,500 (1,134)
	60 seats 34" pitch		1,200 (545)
Forward Cargo Comp't (LH)	52 seats 34" pitch	100 (488)	1,000 (454)
Aft Cargo Comp't		100 (488)	2,000 (908)
Belly Cargo Comp't		65 (317)	1,100 (500)

1.4.0 General Data

Wing	
Wing Span	104' 11.8" (32.000 m)
Wing Chord (root)	13' 9.4" (4.200 m)
" (tip)	4' 11.1" (1.500 m)
" (MAC)	10' 6.1" (3.204 m)
Airfoil (root)	NACA 64A218a = 0.8
" (tip)	NACA 64A412a = 0.8
Angle of Attack (root)	3°
" (tip)	0°
Dihedral	6°19'
Aspect Ratio	10.8
Taper Ratio	0.336
Tail (Horizontal)	
Wing Span	39' 4.4" (12.000 m)
Wing Chord (root)	8' 2.4" (2.500 m)
" (tip)	3' 3.4" (1.000 m)
Airfoil (root)	NACA 63A014
" (tip)	NACA 63A012
Angle of Attack	0°
Dihedral	0°
Aspect Ratio	6.5
Taper Ratio	0.349
Tail (Vertical)	
Height	15' 1.1" (4.600 m)
Wing Chord (root)	14' 9.2" (4.500 m)
" (tip)	6' 6.7" (2.000 m)
Airfoil (root)	NACA 63A012
" (tip)	NACA 63A012
Aspect Ratio	1.5
Taper Ratio	0.419
Fuselage	
Length	86' 3.4" (26.300 m)
Maximum Diameter (Outer)	9' 5.4" (2.800 m)
Landing Gear	
Wheel Size (Main)	12.50 - 16
" (Nose)	24 x 7.7
Tire Size and Pressure (Main)	12.50 - 16 75 psi
" " (Nose)	24 x 7.7 50 psi
Wheel Base	31' 2.6" (9.515 m)
Tread	28' 2.6" (8.600 m)
Maximum Oleo Stroke (Main)	1' 2.2" (0.360 m)
" " (Nose)	1' 1.1" (0.330 m)

Cargo Compartment Volume

	Cargo Compartment Volume cu.ft (m^3)		
	52 seats 38" pitch	52 seats 34" pitch	60 seats 34" pitch
Forward Cargo Comp't (R/H)	116 (3.28)	176 (4.97)	94 (2.66)
Forward Cargo Comp't (L/H)	-	82 (2.31)	-
Aft Cargo Comp't	171 (4.84)	171 (4.84)	171 (4.84)
Belly Cargo Comp't	70 (1.98)	171 (4.84)	171 (4.84)
	357(10.10)	499(14.10)	335 (9.48)

Engine Data

Reduction Ratio	0.0775
Direction of Rotation	Engine ..... Clockwise viewed from rear Propeller... Counterclockwise viewed from rear
Engine Performance	Average Rating at Sea Level, standard atmospheric conditions

	Speed rpm	Shaft Horse Power HP	Jet Thrust LBS(Kg)	Equivalent Shaft Horse power HP	Specific Fuel Consumption LBS/Hr (Kg/Hr)
Take-off (with W/M injection)	15,000	2,775	740(336)	3,060	-
Take-off (without W/M injection)	15,000	2,400	660(299)	2,660	0.708(0.321)
Maximum Continuous	15,000	2,400	660(299)	2,660	0.708(0.321)
Maximum Cruising	14,200	1,880	525(238)	2,080	0.760(0.345)

Propeller Data

Diameter	14'6" (4.420m)
Pitch	0° to 84°15'

Chapter 2 STRUCTURE

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Chapter 2 STRUCTURE

2.1 Construction -- Description

2.1.1 General

The YS-11 described herein has stressed-skin structure. Metallic materials used in the YS-11 are mainly aluminium alloys 2024 and 7075, all sheet metal used for structure being alclad. All other metallic components are surface-treated.

The rivets and screws exposed on the skin surface, except those for the elevators, rudder, flaps and tail cone, are mostly those with flush heads. The access doors are provided flush with the skin.

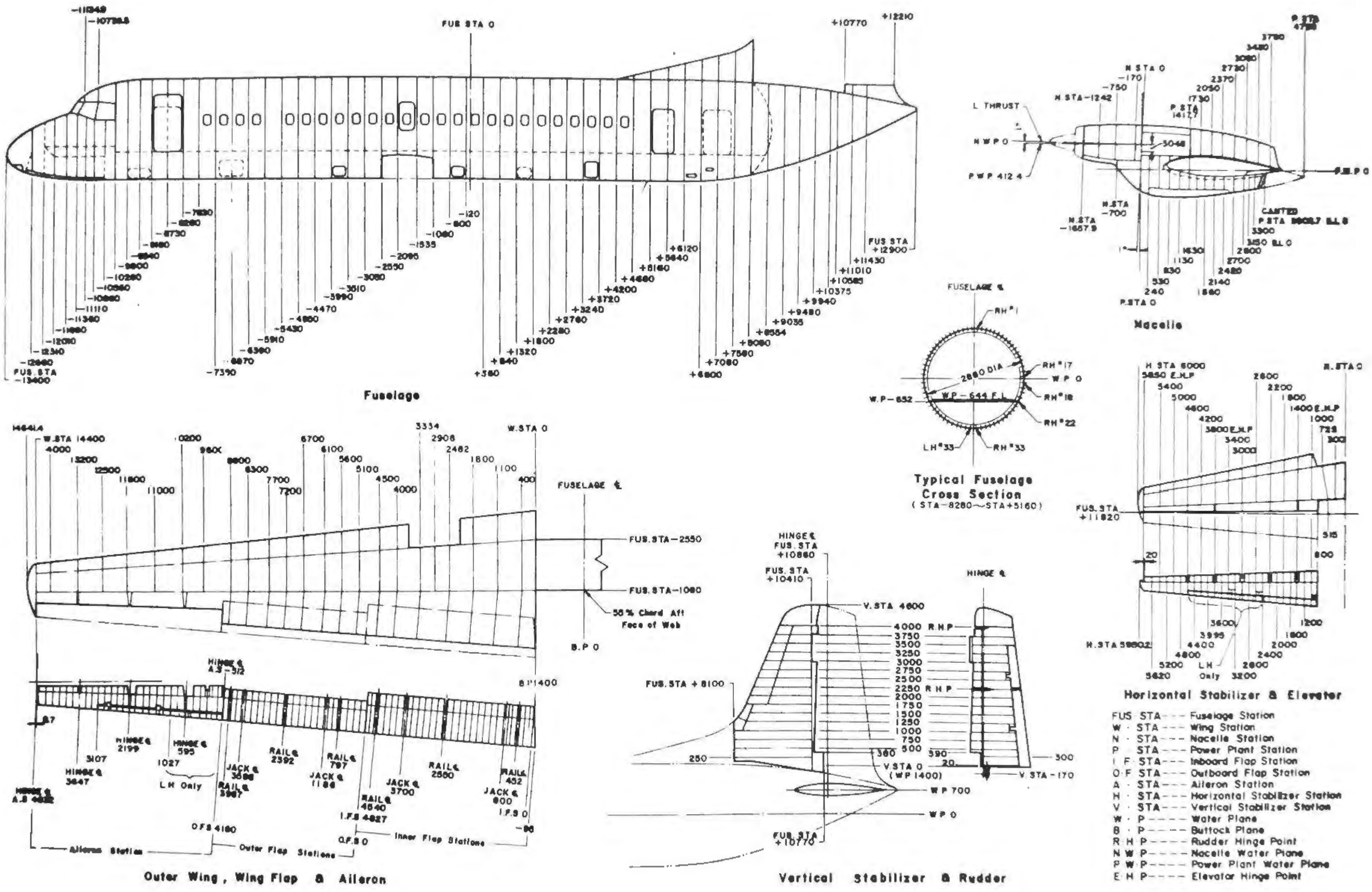
Hermetically closed structural sections are ventilated, drained, and protected from rain water as necessary. Each of these sections has an access door for easy access to the interior for inspection.

2.1.2 Station Diagram

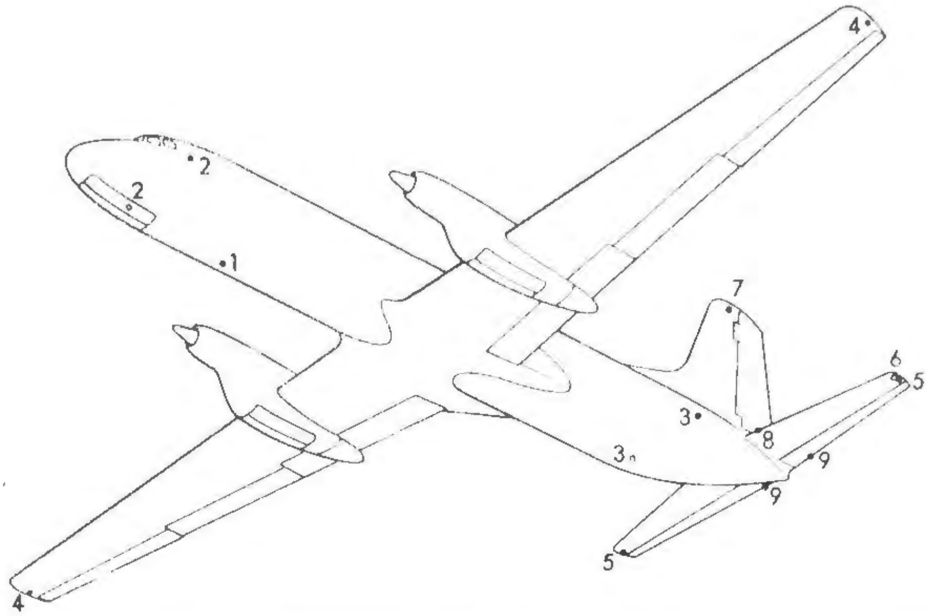
The airframe structure is provided with station numbers which are shown in Fig. 2-1.

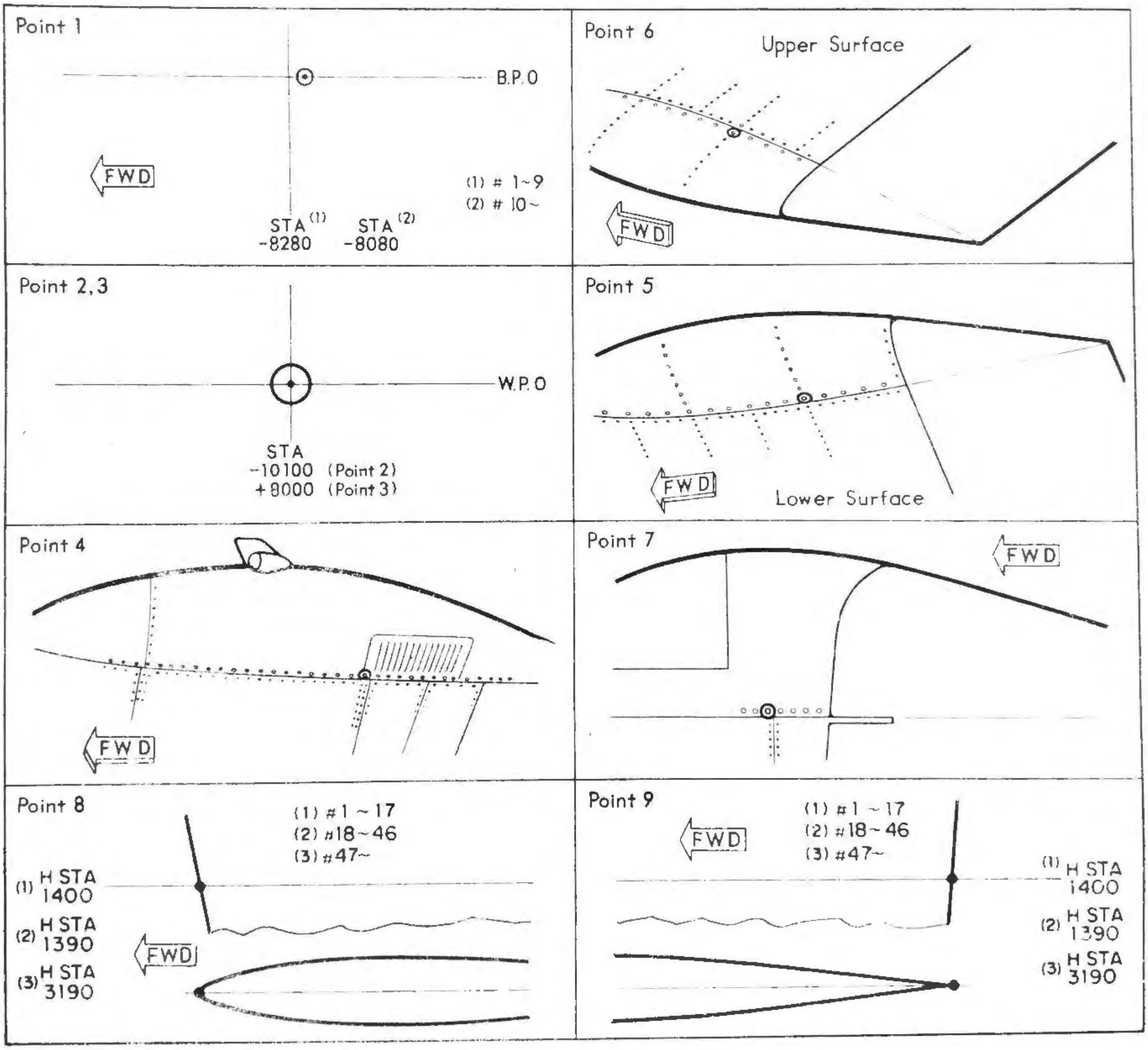
2.1.3 Alignment

Fig. 2-3 shows the alignment check points of the airframe structure and their numbers.



Station Diagram
Figure 2-1

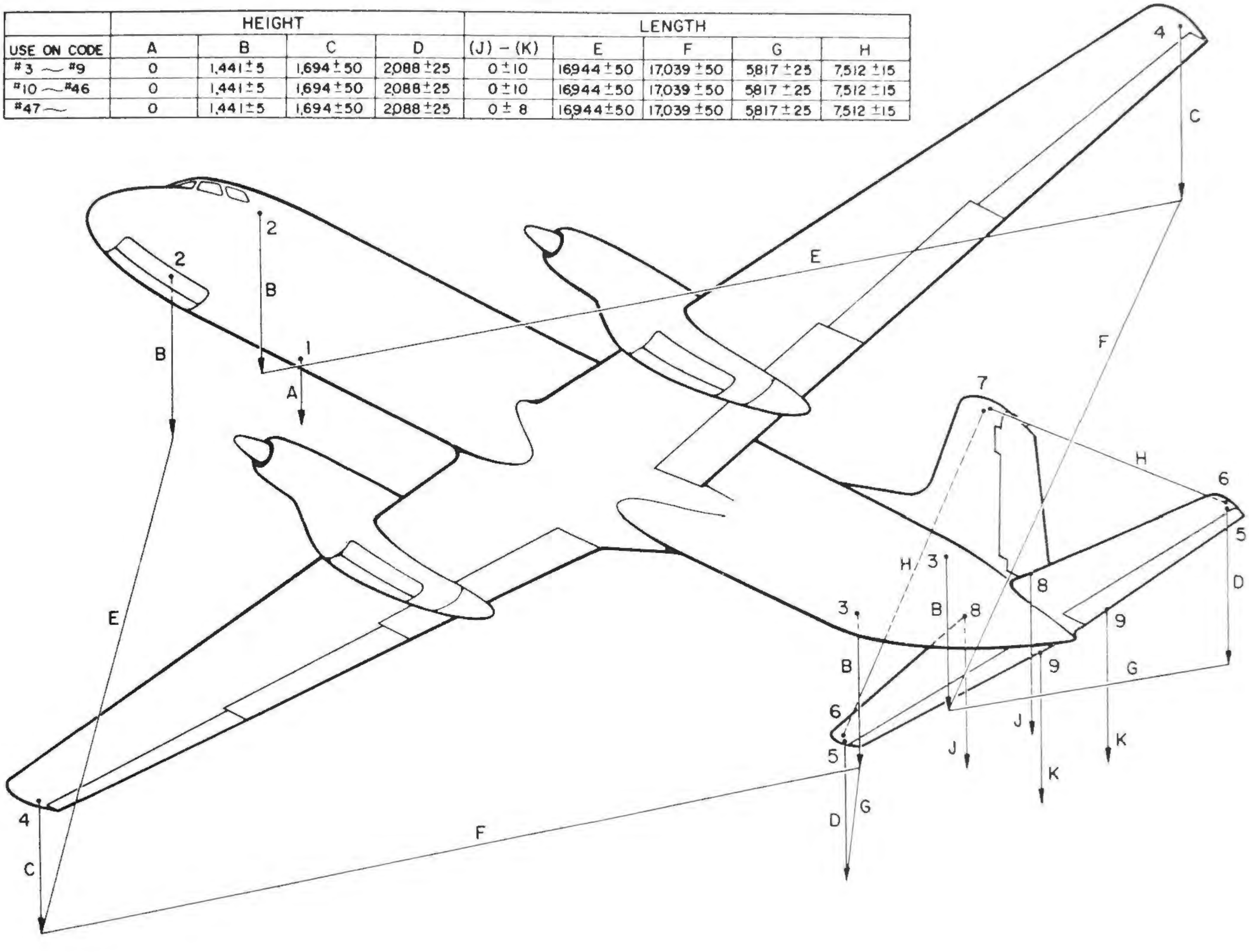




Alignment Point

Figure 2-2

	HEIGHT				LENGTH				
USE ON CODE	A	B	C	D	(J) − (K)	E	F	G	H
#3 ~ #9	0	1,441 ± 5	1,694 ± 50	2,088 ± 25	0 ± 10	16,944 ± 50	17,039 ± 50	5,817 ± 25	7,512 ± 15
#10 ~ #46	0	1,441 ± 5	1,694 ± 50	2,088 ± 25	0 ± 10	16,944 ± 50	17,039 ± 50	5,817 ± 25	7,512 ± 15
#47 ~	0	1,441 ± 5	1,694 ± 50	2,088 ± 25	0 ± 8	16,944 ± 50	17,039 ± 50	5,817 ± 25	7,512 ± 15



Alignment Check
Figure 2–3

2.2 Structure of Fuselage

2.2.1 General

The fuselage has stressed-skin structure, consisting mainly of forward, mid and aft fuselages. These sections are joined at Sta -10260 and Sta +8080, with 1/4 inch tension bolts.

The forward end (Sta -12660 to Sta -13400) of the fuselage is a nose cap or radome which is installed with hinges for easy removal and installation.

The section between Sta -8280 and Sta +6120 of the mid fuselage has a uniformly round cross-section, 2,880 mm in diameter. The frames in this section, except a few, are spaced at an interval of 480 mm. In the section between Sta -2550 and -1080, the center wing is attached to the fuselage permanently.

The section between Sta +11430 and Sta +12900 is a tail cone attached to the fuselage with screws.

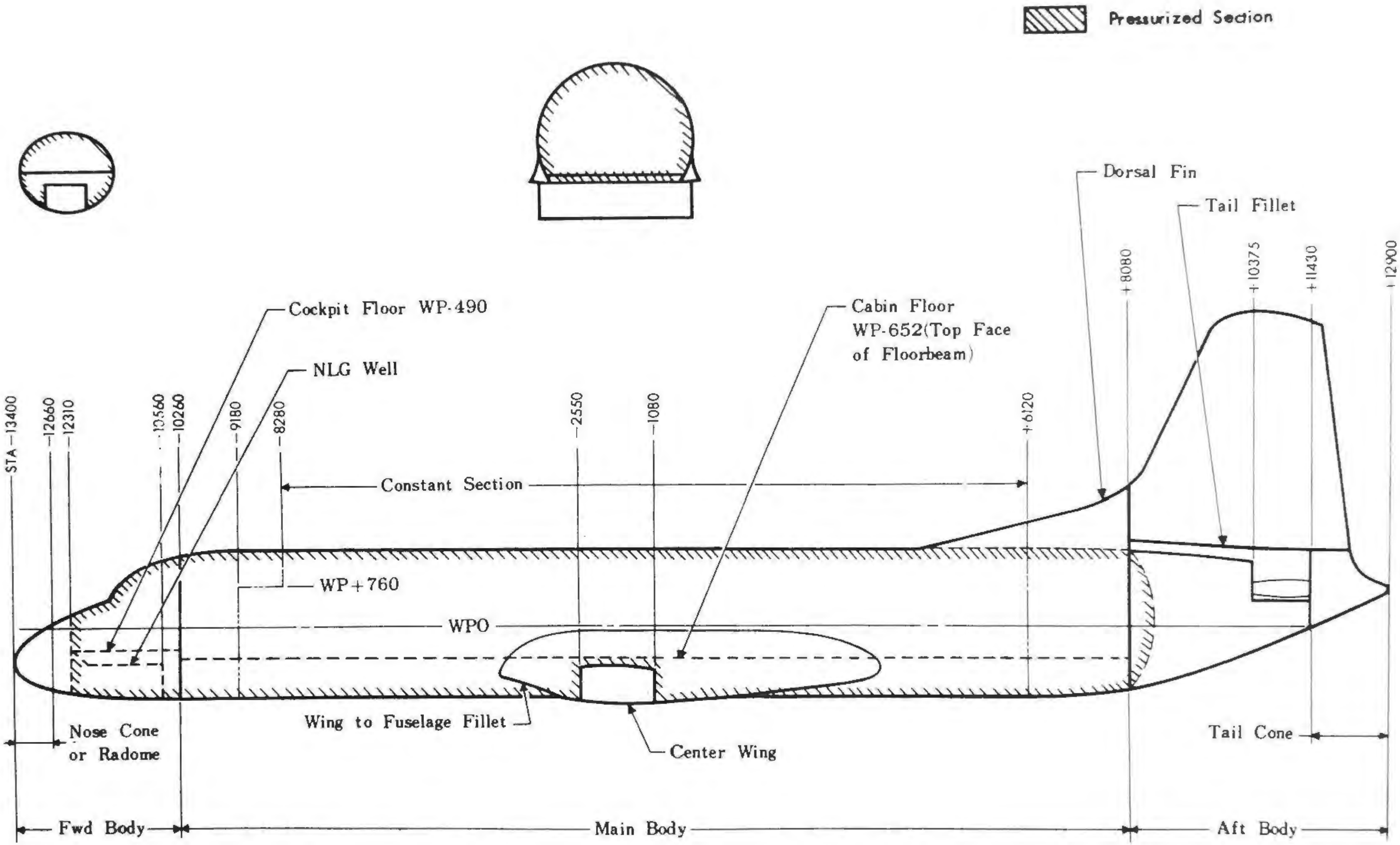
The section between Sta -12310 and Sta +8080, except the nose gear wheel well and the center wing, is pressure-sealed and can be pressurized to the normal operating pressure of 4.16 psi. The pressurized area is divided by the floor into upper and lower sections. The underfloor section is divided into the following five sub-sections: from fore to aft, electrical compartment (Sta -10560 to Sta -8280), underfloor baggage compartment (Sta -8280 to Sta -3990), flight control compartment (Sta -3990 to Sta -2550), hydraulic compartment (Sta -1080 to Sta +360) and air conditioning compartment (Sta +360 to Sta +5160). Each of these compartments has a door which can be opened and closed from outside the plane. Ice plates are attached to those portions of fuselage skin which are adjacent to the propellers.

The fuselage structure mainly consists of frames, stringers and skin, which are secured by shear ties and clips.

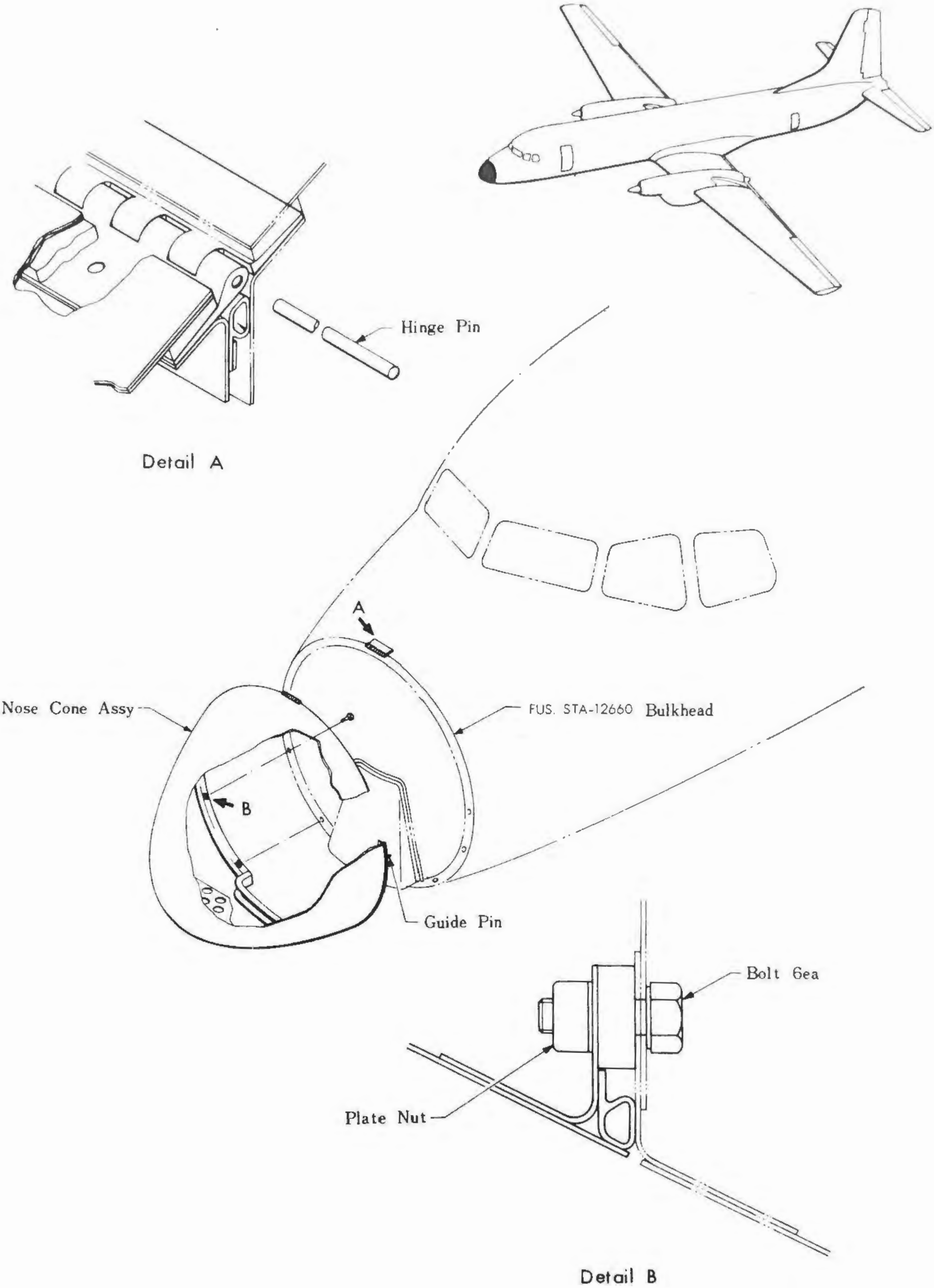
The sealing material for the pressurized section of the fuselage is mainly PR-1222. The butt ends of the skin, such as those at the fuselage joint sections, are waterproofed with sealing material PR-341.

2.2.2 Material for Fuselage Structure

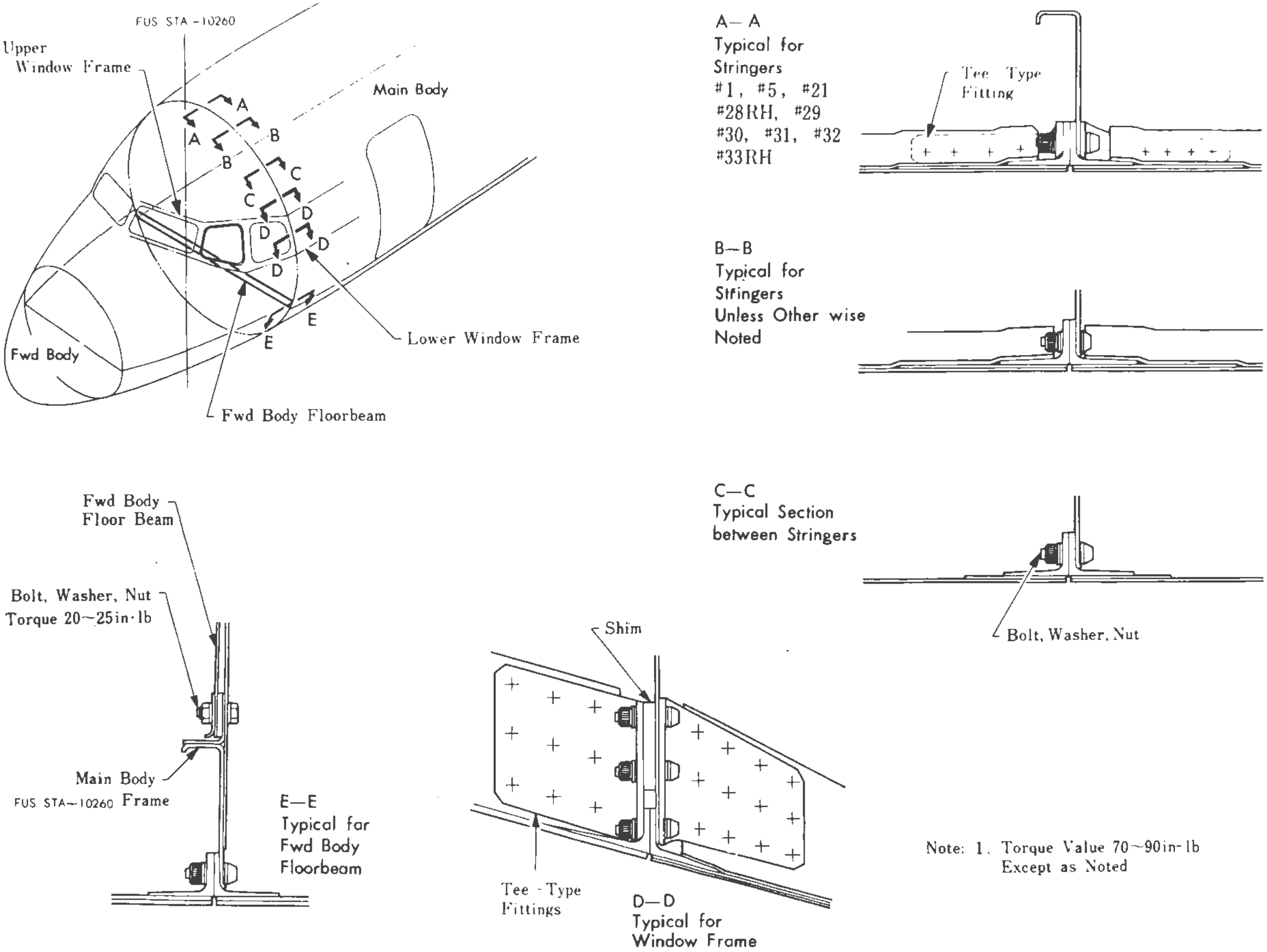
The fuselage is of such construction that longerons are installed around the frames and covered by the skin. The skin is reveted to the frames (through shear ties) and to the longerons. For riveting, MS20426 AD flush head rivets are mostly used.



Fuselage Structure Assembly
Figure 2-4

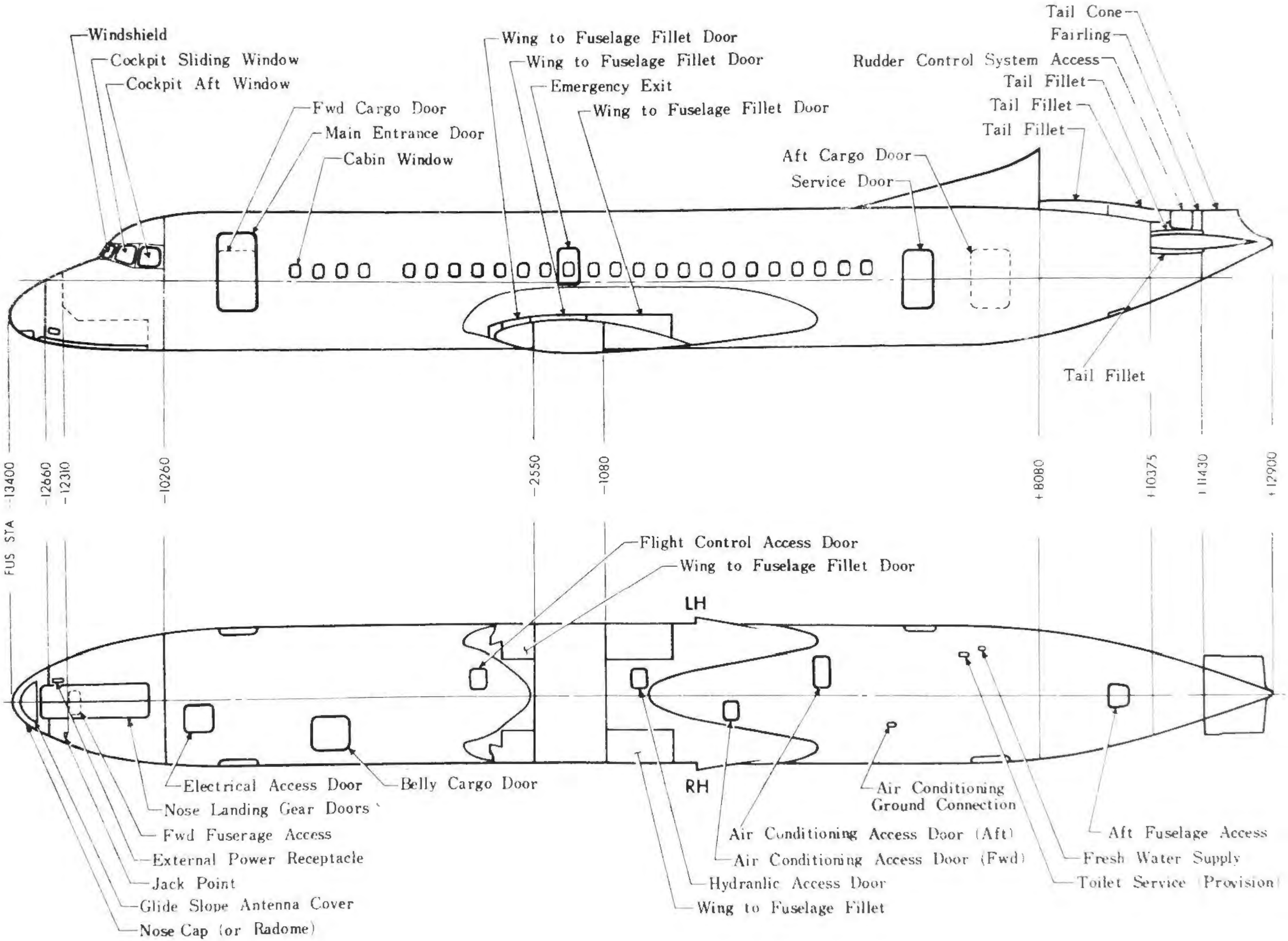


Nose Cone Installation
Figure 2–5



Note: 1. Torque Value 70~90in-lb Except as Noted

Installation of Fuselage Aft Body
Figure 2-6



Fuselage Station, Windows, Doors and Access Provisions

Figure 2-7

The gage and material of the fuselage skin are roughly as follows:

Fore from Sta -10260	2024C-T42	0.032"
Sta -10260 to Sta +8080	2024C-T3	0.032"
(however, fuselage-wing joint sections use:		
	2024C-T3	0.05" to 0.063")
Aft from Sta +8080	2024C-T42	0.032"

There are 66 longerons, which decrease in number gradually in the fore and aft portions of the fuselage as the extreme ends are approached. Most longerons are made of "Z" shape material; some longerons, angle shape plate. The material of the longerons is mostly 7075C-T6.

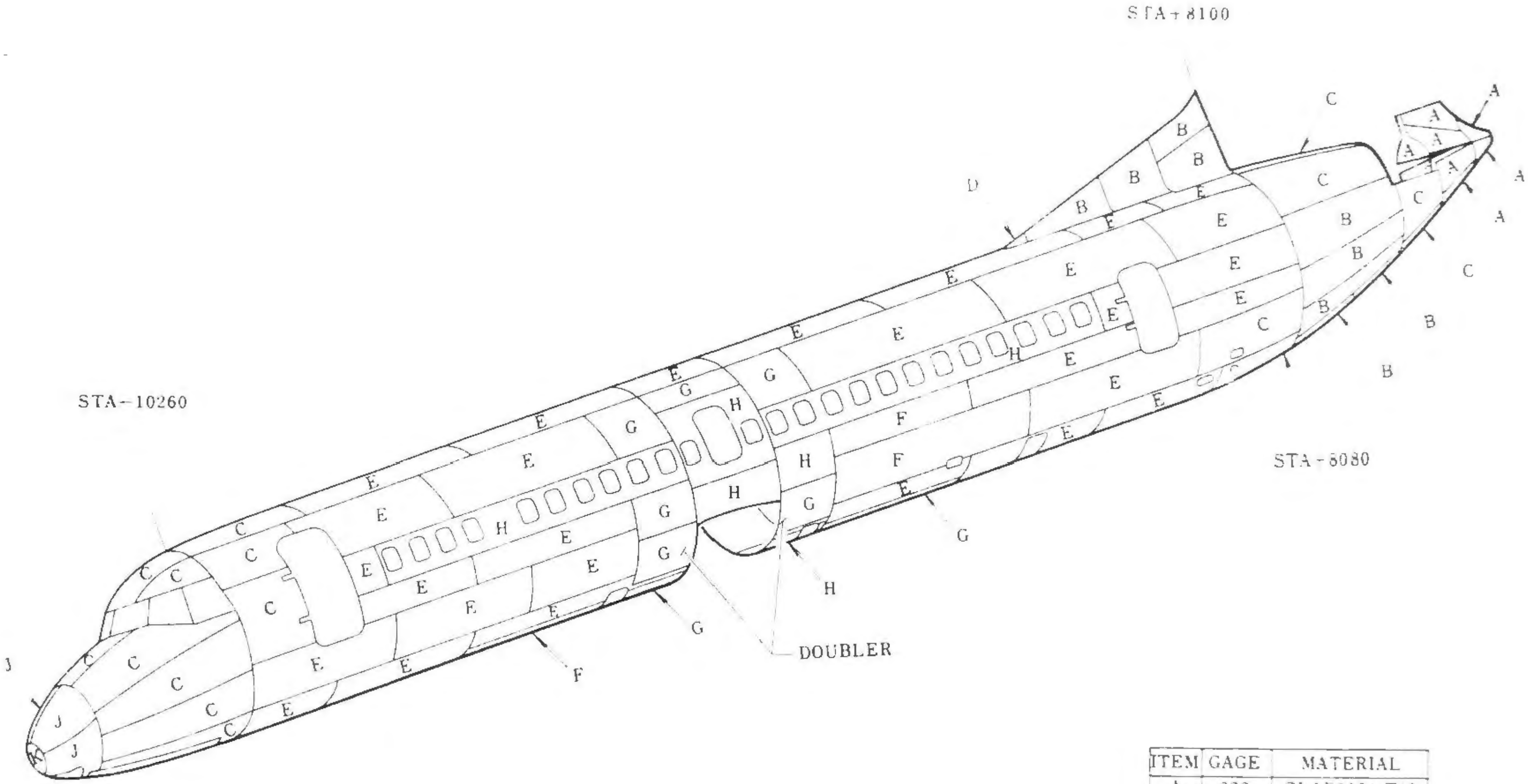
The frames are located at the station numbers shown in Fig. 2-1 . In the center and aft fuselages, the most of the frames have a "Z"-shape cross section and is made of 7075C-T6, 0.050" or 0.056" thick. In the forward fuselage, the most of the frames have "⊏" shape cross-section and is made of 7075C-T6, 0.050", 0.056" or 0.063" thick. The frames in the joint sections of the forward, mid and aft fuselages are made of K2008 or K2009 extruded shape material.

At Sta -10560 is attached a frame to support the nose gear wheel keel. At Sta -1080 and Sta -2550 are attached frames to fix the main wing. At Sta +8554, Sta +10375 and Sta +11430 are attached frames to fix the tail wing. Those frames are made especially strong to bear their respective loads.

2.2.3 Sealing of Fuselage

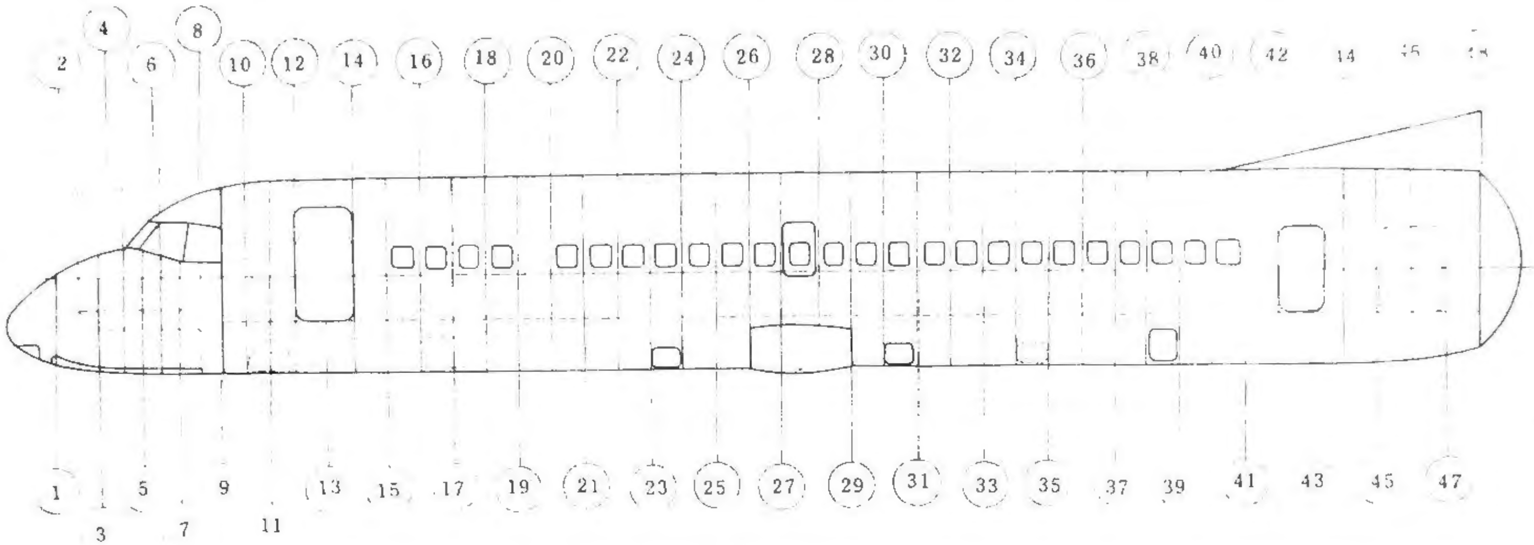
Sealing is broadly classified into air-tight sealing and water-tight sealing. Air-tight sealing is applied to the pressurized surface, where rivet and bolt heads are covered completely with sealing material.

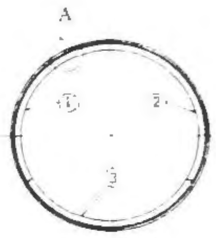
The lap jointed portions of the skin are riveted with sealing material in between. Water-tight sealing is applied from outside the aircraft to cover the ends of skin sheets at the joint sections.



ITEM	GAGE	MATERIAL
A	.020	CLAD2024-T42
B	.025	CLAD2024-T42
C	.032	CLAD2024-T42
D	.040	CLAD2024-T42
E	.032	CLAD2024-T3
F	.040	CLAD2024-T3
G	.050	CLAD2024-T3
H	.063	CLAD2024-T3
J	.025	6061-T6
K	.040	6061-T6

Fuselage Plates/Skin-General
Figure 2-8

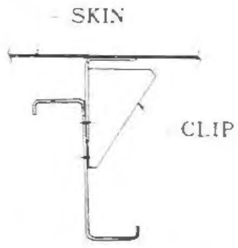




TYPICAL FRAME SECTION

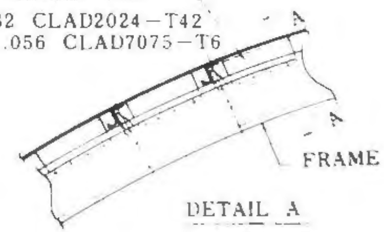
ITEM	STATION	GAGE 1 2	GAGE 3	ITEM	STATION	GAGE ① ②	GAGE ③	ITEM	STATION	GAGE 1 2	GAGE 3
1	−12660	.050		20	−5430	.050	.056	39	+3720	.050	.056
2	−12310	.056		21	−4950	.050	.056	40	+4200	.050	.056
3	−12010	.050		22	−4470	.050	.056	41	+4680	.050	.056
4	−11660	.063		23	−3990	.050	.056	42	+5160	.050	.056
5	−11360	.063		24	−3510	.050	.056	43	+5640	.050	.056
6	−11110	.050		25	−3030	.050	.056	44	+6120	.050	.056
7	−10860	.063		26	−2550	K2018 56		45	+6600	.050	.056
8	−10560	.056		27	−2095	.050	.056	46	+7080	.050	.056
9	−10260	.056		28	−1535	.050	.056	47	+7580	.050	.056
10	−9900	.050	.056	29	−1080	K2018		48	+8080	.056	
11	−9540	.050	.056	30	−600	.050	.056				
12	−9180	.056		31	−120	.050	.056				
13	−8730	.050	.056	32	+360	.050	.056				
14	−8280	.056		33	+840	.050	.056				
15	−7830	.050	.056	34	+1320	.050	.056				
16	−7350	.050	.056	35	+1800	.050	.056				
17	−6870	.050	.056	36	+2280	.050	.056				
18	−6390	.050	.056	37	+2760	.050	.056				
19	−5910	.050	.056	38	+3240	.050	.056				

NOTE: ALL MATERIALS ARE CLAD7075−T6



SECTION A−A

SHEAR TIE
.032 CLAD2024−T42
.050 .056 CLAD7075−T6

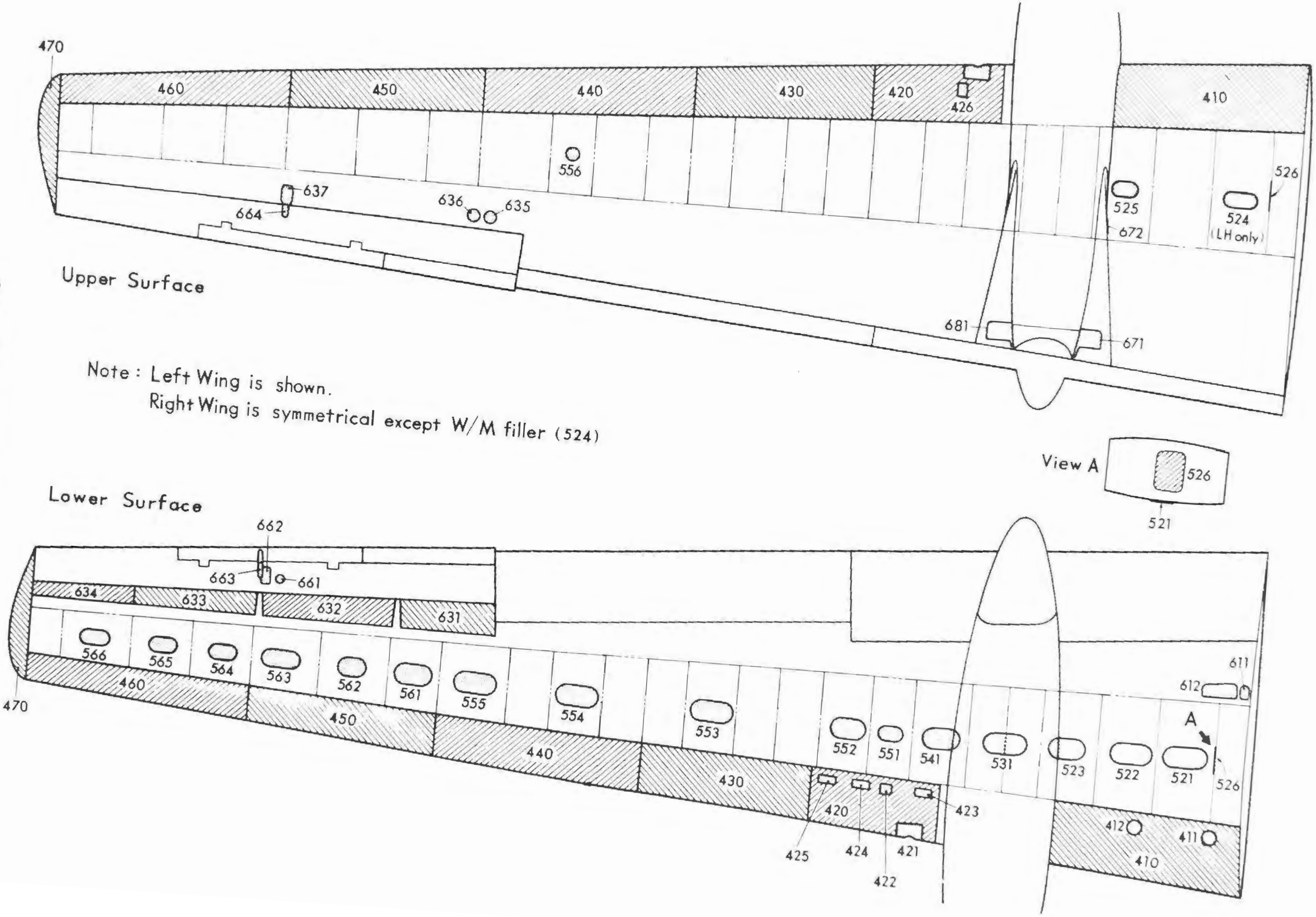


DETAIL A

Frame Materials — General
Figure 2-9

Number	Side	Type	Purpose or Access to
611	L	H	Fuel Cross-feed Line Drain
"	R	H	Fuel Power Drain Valve
612	L, R	H	Pressure Refueling Panel
631	L, R	S*	Aileron Leading Edge * With Pin Hinge
632	L, R	S*	" * "
633	L, R	S*	" * "
634	L, R	S*	" * "
635	L, R	S	Aileron Stopper Adjustment
636	L, R	S	Aileron Stopper Adjustment
637	L, R	S	Aileron Push Pull Rod Cover
661	L, R	S	Spring Installation
662	L, R	S	Spring Unit
663	L, R	S	Aileron Spring Tab Push Pull Rod Cover
664	L, R	S	Horn-Spring Tab Cover
671	L, R	S	Exhaust Exit Construction
672	L, R	H	Life Line Fitting -- (aft)
681		S	Exhaust Exit Construction

Note 1: Refer to 28-11-0 Integral Fuel Tank for Access Plate Mounting



Outer Wing Access Plates
Figure 2-10

2.3 Main Wing

2.3.1 General

The main wing has all-metal, cantilever, stressed-skin structure. It consists of center wing and outer wings. The center wing is fixed to the fuselage. The outer wings are fixed to the center wing at WS 0 with 13 tension bolts on the upper surface and 11 on the lower surface and with seven shear bolts on the front beam and eight on the rear beam, arranged on the top and bottom ends. In the outer wings, the leading edges, trailing edges, tips, ailerons, flaps and nacelles are installed on the box-type structures consisting of front and rear spars, ribs, upper and lower skins and stringers.

The inside of the section between WS 4000 and WS 9600 forms an integral tank with its inside sealed.

Bag tanks can be installed in the section between WS 0 and WS 2482. The inner surface of the spar-to-spar structure in this portion is provided with lining plates.

2.3.2 Center Wing

The center wing is of two-spar box-type, fixed permanently to the center portions of the frames at Sta 2550-and Sta-1080 on the fuselage. It is composed of a front spar and a rear spar, upper and lower skins which have "ᒧᒪ" shape stringers made of extrusion material and five reinforcing ribs. The reinforcing rib at BP 1100 has fittings for the wing-fuselage joint and the center wing-outer wing joint.

2.3.3 Outer Wing Spar-to-Spar Structure

The spar-to-spar structure constitutes the major structural part of the outer wing. The box beam of each wing is composed of a front spar and a rear spar, 24 ribs connecting these spars, and upper and lower skins reinforced with stringers.

The ribs have two varieties: the truss type and the web type. The truss type ribs are so designed that the truss members can be removed to facilitate work inside the wing.

2.3.4 Outer Wing Leading Edge Structure

The leading edge consists of six sections, each of which is fixed by screws to the ribs riveted to the front spar flange of the main wing.

The portion between the fuselage and the nacelle is formed with skin and false ribs, and has no anti-icing system. The portion of leading edge outside the nacelle has double skin, and is equipped with rubber boots and their piping.

2.3.5 Outer Wing Trailing Edge Structure

The trailing edge consists of ribs, stringers and skin, and is riveted to the rear spar. It supports the inboard and outboard flaps between WS 0 and WS 9038, and the aileron between WS 9038 and WS 14400.

The ribs in the trailing edge of the flap comprise two varieties: cantilever ribs and false ribs. Their stiffeners are detachable.

The rear end of the lower surface skin is rubber-sealed to fill the clearance between the lower surface of the trailing edge and the flap at the time of FLAP UP configuration.

In the trailing edge of the aileron assembly, a bulkhead for aileron sealing cloth is installed spanwise. The lower side of the trailing edge forms an access door, which can be opened when the aileron is serviced.

2.3.6 Wing Tip

The wing tip consists of skin and seven fairing elements, and has a wing tip light. It is fixed to the outer wing with screws.

2.3.7 Outer Wing Skin

The material and thickness of the outer wing skin are shown in Figs. 2-17 and 2-18.

2.3.8 Flaps

The flap is of the Fowler type, and has two drag links with screw jacks to actuate the flap. Three roller carriages installed on the flap travel along the circular rails on the main wing trailing edge.

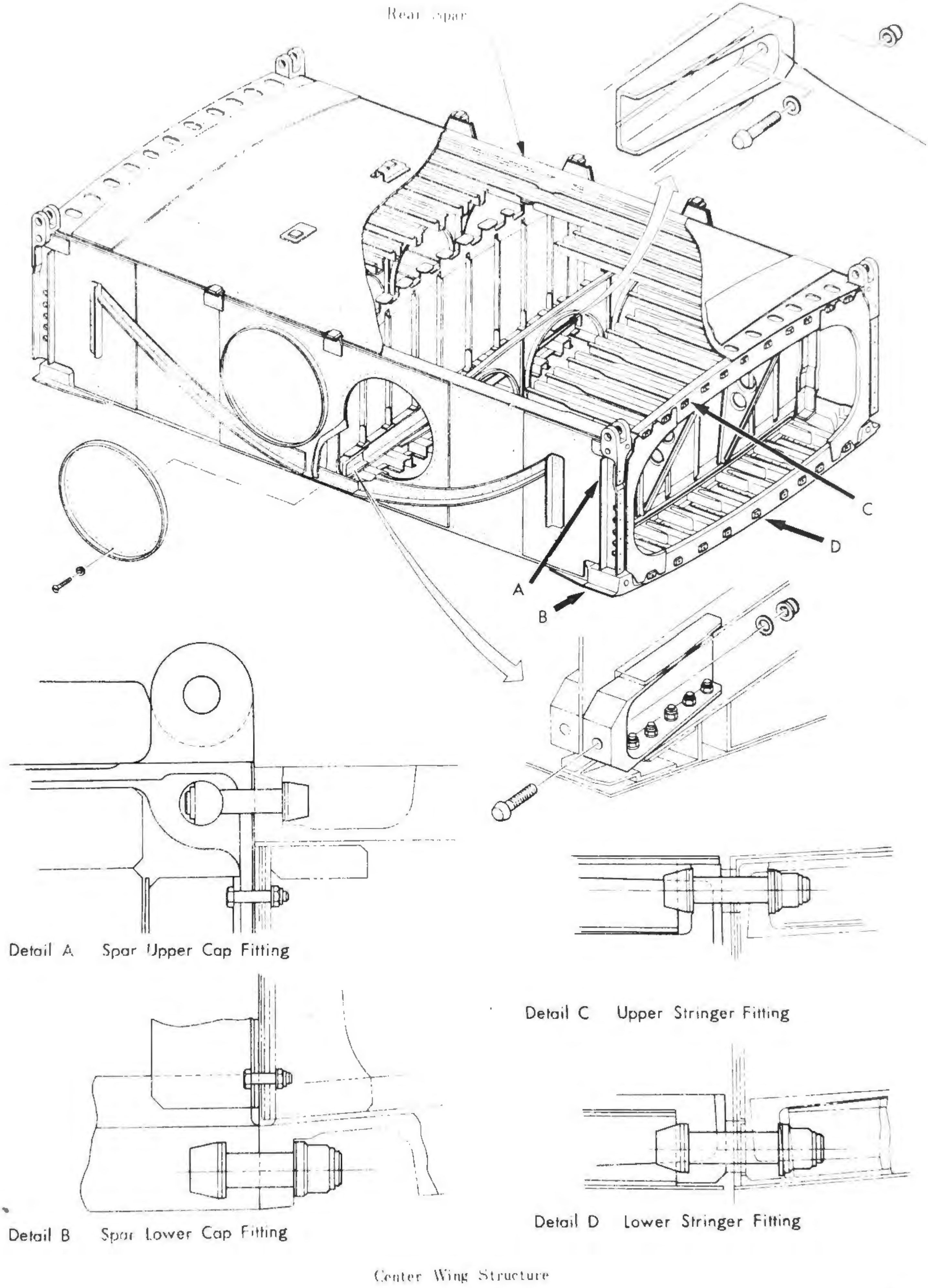
Both inboard and outboard flaps are composed of main spars and front and rear spars; the spars and ribs are formed by bending sheet. The skin is reinforced with stringers. On the lower side of the inboard flap, a fairing cone is installed to fair the rear of the nacelle at the time of FLAP UP configuration.

2.3.9 Ailerons

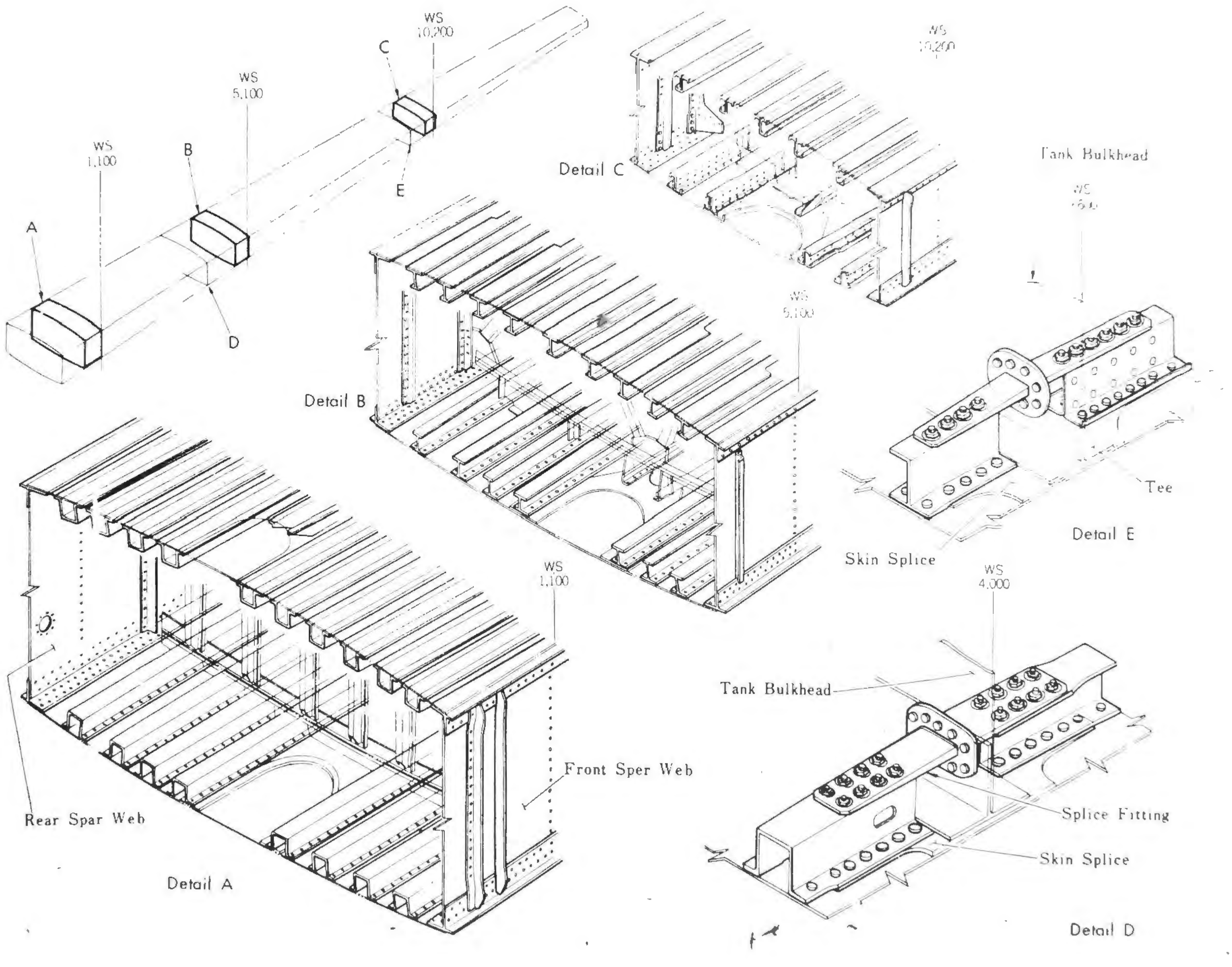
The aileron has all-metal, single-span, stressed-skin structure. Nylon curtain seal is provided on its leading edge. It is connected to the main wing trailing edge with five hinges.

A spring tab is located at the center of the trailing edge of each aileron; a trim tab is on the inboard side of the trailing edge of the L.H. aileron.

On the leading edge except the hinge portion, balance weights with bar shape are arranged spanwise to keep static moment at 250 ± 50 mmKg (nose-heavy).

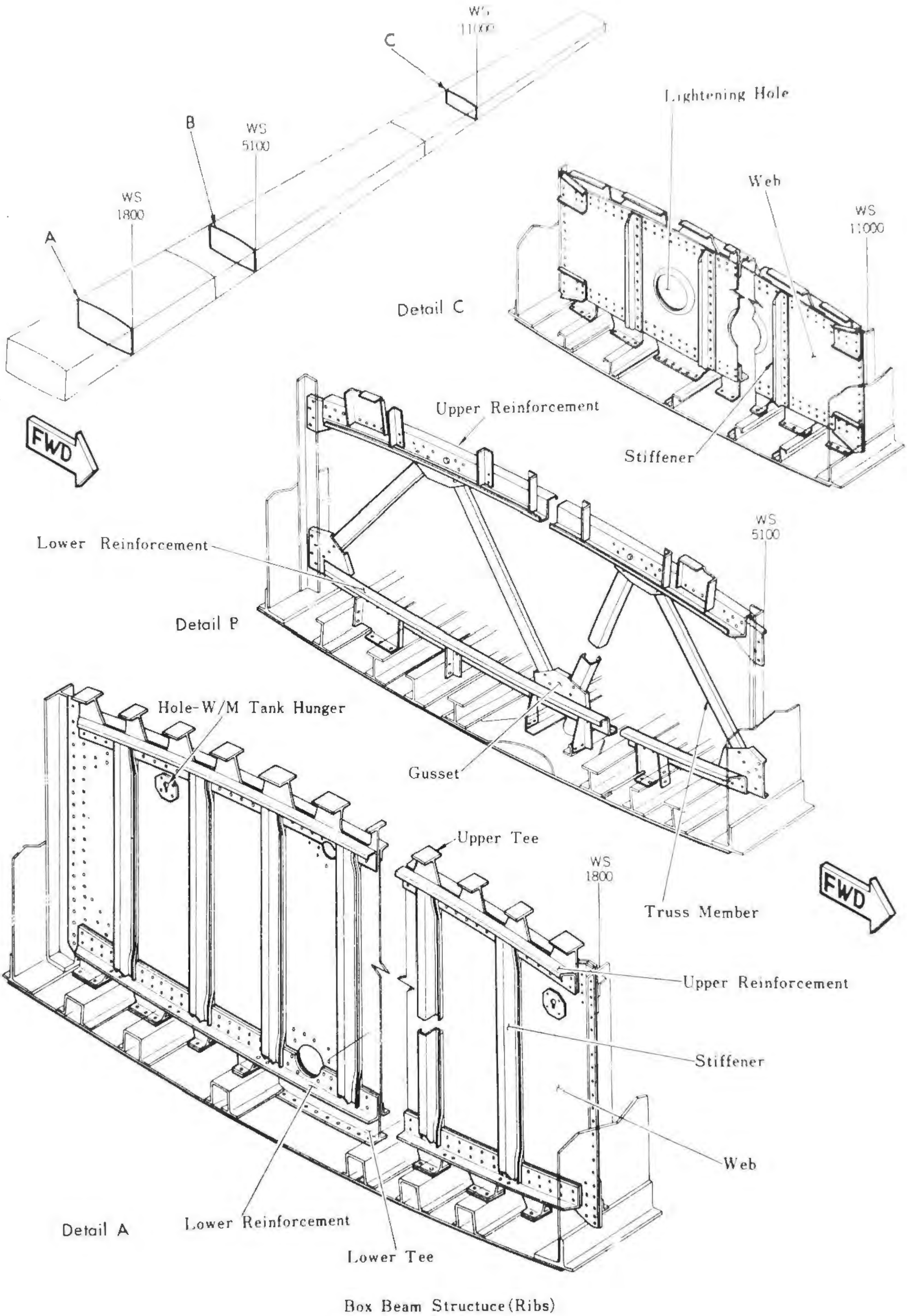


Center Wing Structure
Figure 2-11



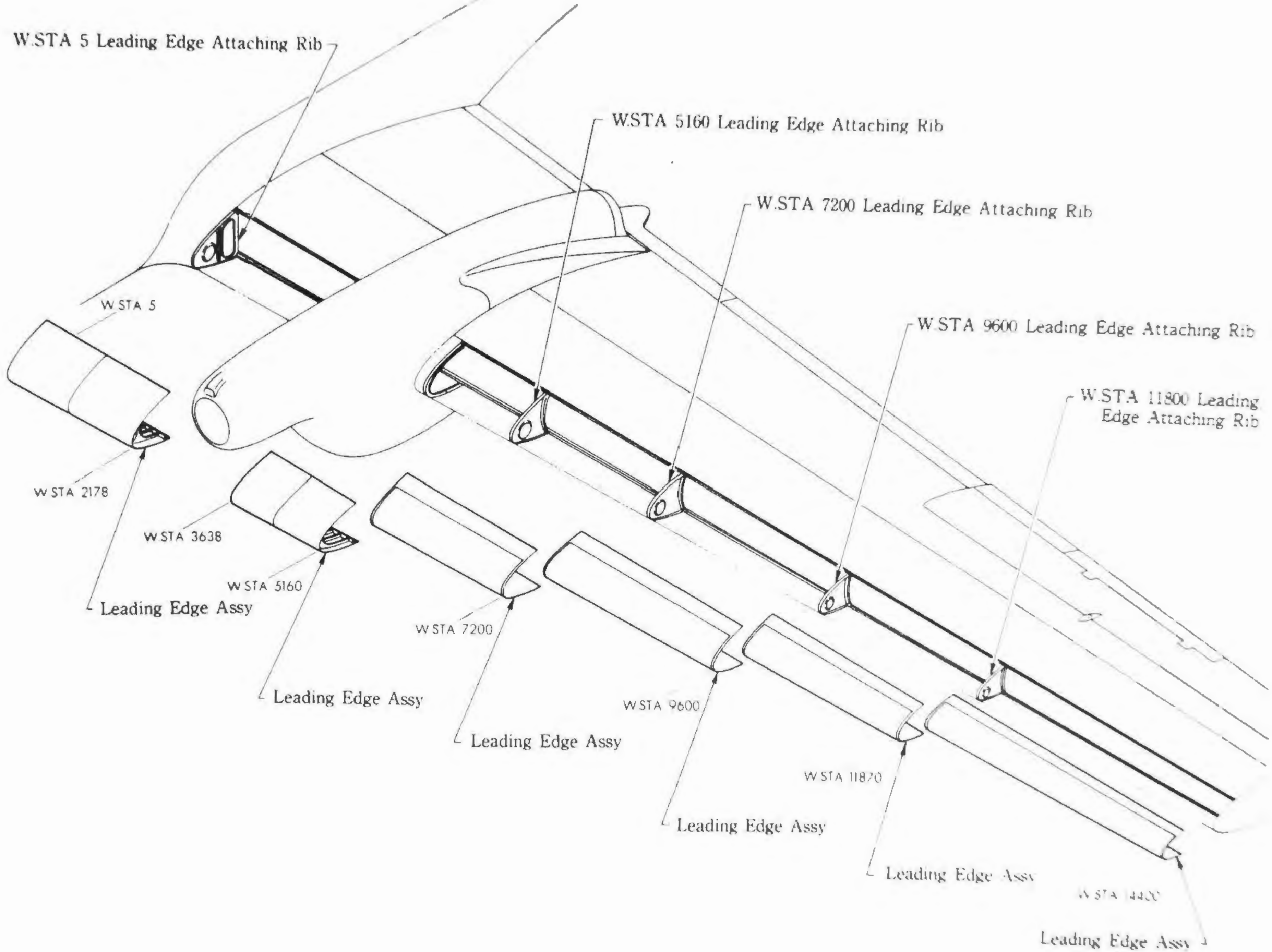
Box Beam Structure (Spars and Stringars)

Figure 2-12

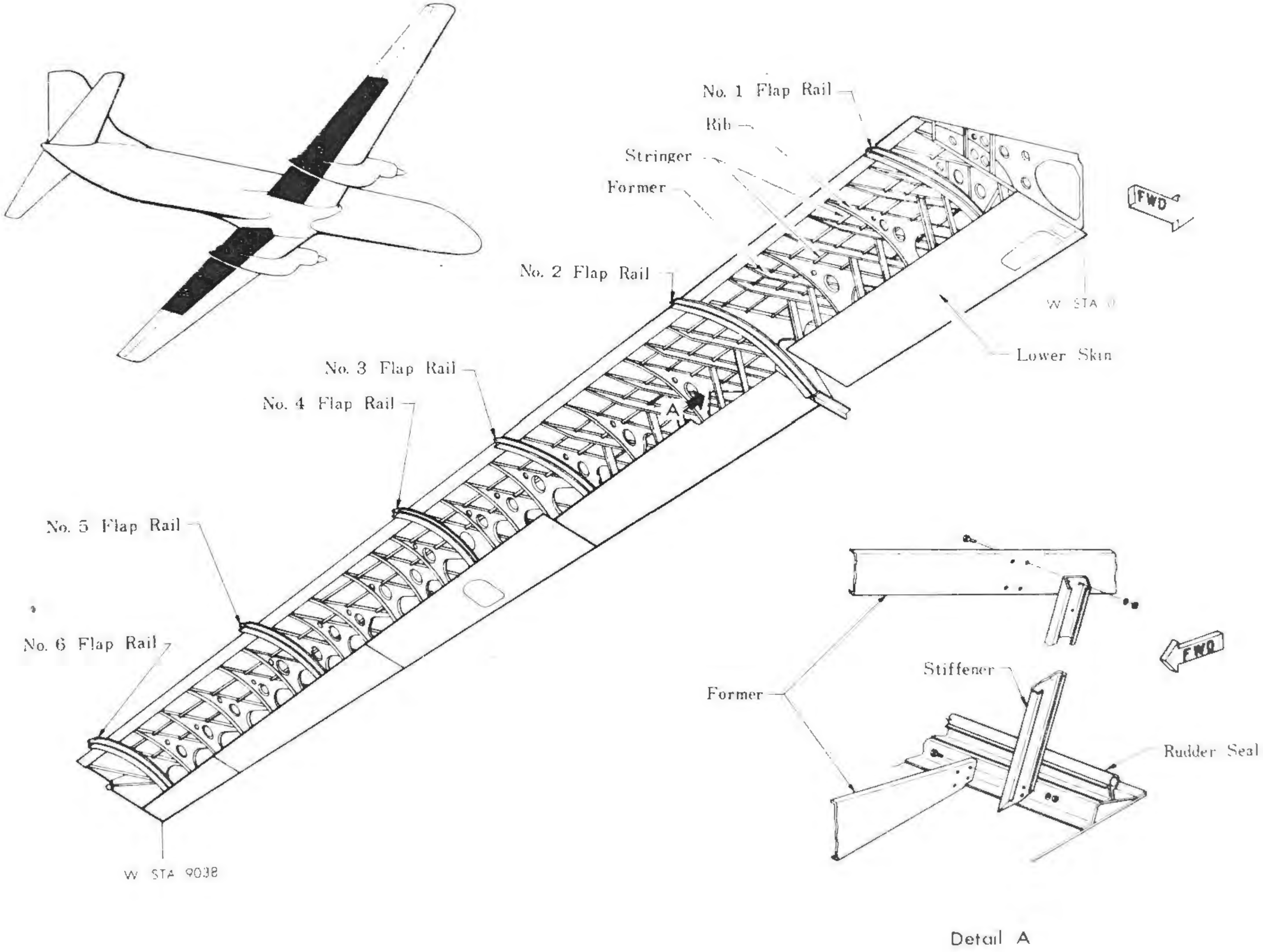


Box Beam Structuce(Ribs)

Figure 2-13

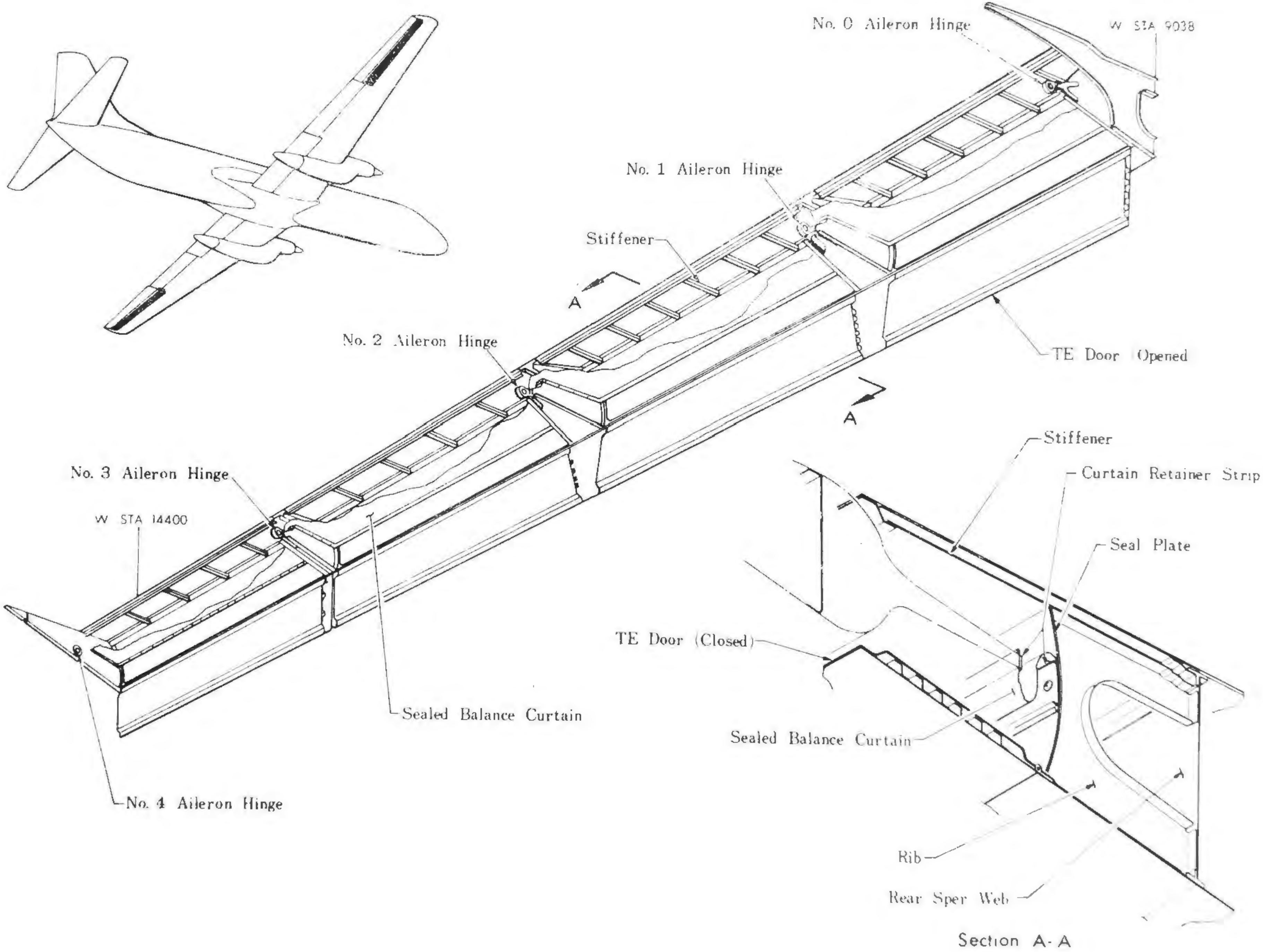


Leading Edge Component
Figure 2-14

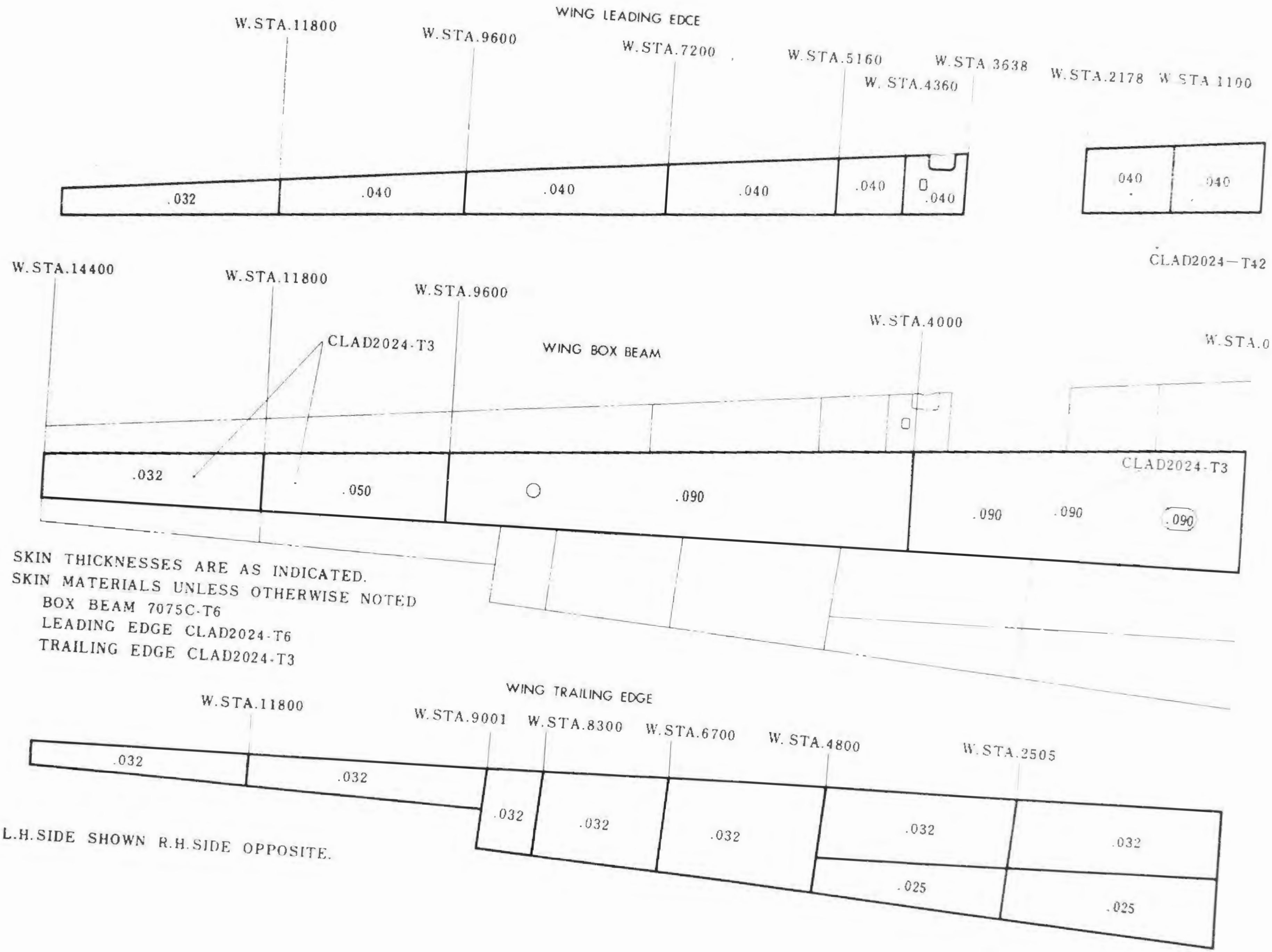


Trailing Edges
Figure 2-15

The tabs are all-metallic. The spring tab is joined to the aileron with hinges at three points, and trim tab, with piano hinges. Static moment of the spring tab is 10 ± 3 mmKg (nose-heavy).



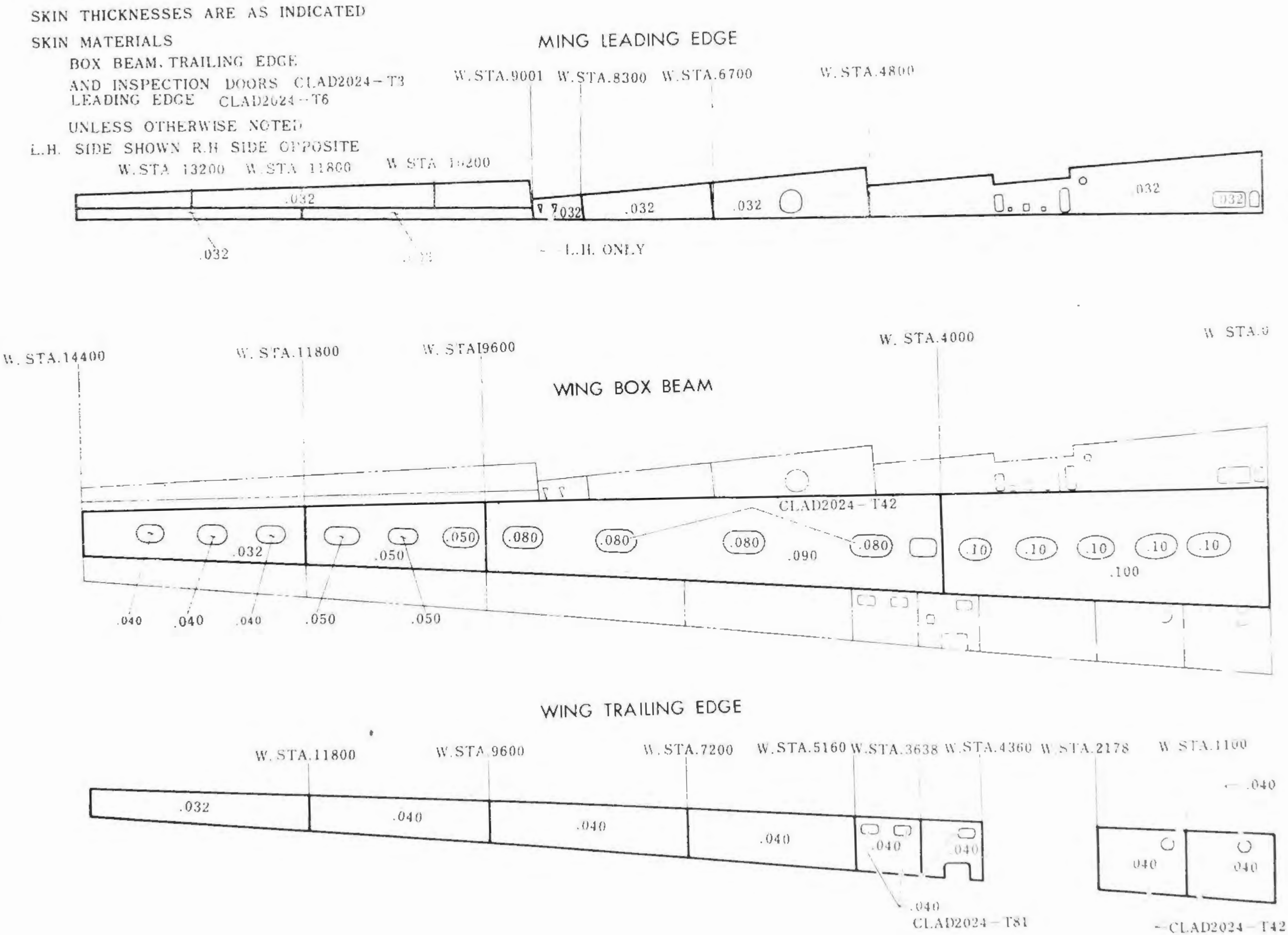
Trailing Edges
Figure 2-16



SKIN THICKNESSES ARE AS INDICATED.
SKIN MATERIALS UNLESS OTHERWISE NOTED
BOX BEAM 7075C-T6
LEADING EDGE CLAD2024-T6
TRAILING EDGE CLAD2024-T3

L.H.SIDE SHOWN R.H.SIDE OPPOSITE.

Skin Sections — Outer Wing Section, Top
Figure 2-17



Skin Sections-Outer Wing Section Bottom
Figure 2-18

2.4 Tail Wing

2.4.1 General

The tail wing consists of all-metal horizontal stabilizer, vertical stabilizer, elevators, rudder and fillets, each of which is detachable.

The stabilizers and the rudder have stressed-skin structure with spars, longerons and skin as reinforcing members. The top ends of the vertical stabilizer and the rudder are made of formed fabric reinforced plastic material; the others are made primarily of material 2024.

As for the fillets, part of the dorsal fin is fixed to the upper part of the aft fuselage, and the others are detachable, streamlining the aft fuselage, the tail cone and the tail wing joint section.

Fig. 12-19 shows the inspection holes and the servicing holes for maintenance of the tail wing.

2.4.2 Horizontal Stabilizer

The horizontal stabilizer has two-spar structure; the front and rear spars are located at 17.5% and 55% of wing chord, respectively. The right-hand and left-hand stabilizers are connected at the center of the fuselage to form a monocoque structure. The portion between the two spars is formed with ribs, longerons and skin. Joint fittings, four in all, are provided in front of H. Sta 770 and behind H. Sta 500 of the front spar. They mate with the joint fittings on the fuselage side, the forward portion being joined with two taper bolts and sleeves and the aft portion with two tension bolts.

Throughout the upper and lower sides of the front spar are provided hinges to which the leading edge assembly is attached with stainless steel wire. In the leading edge assembly, a rubber boot type anti-icing system is provided as in the main wing.

The trailing edge is faired with ribs. Hinges to install the elevator are located at H. Sta 300, 1400, 3 800 and 5 800 of the rear spar.

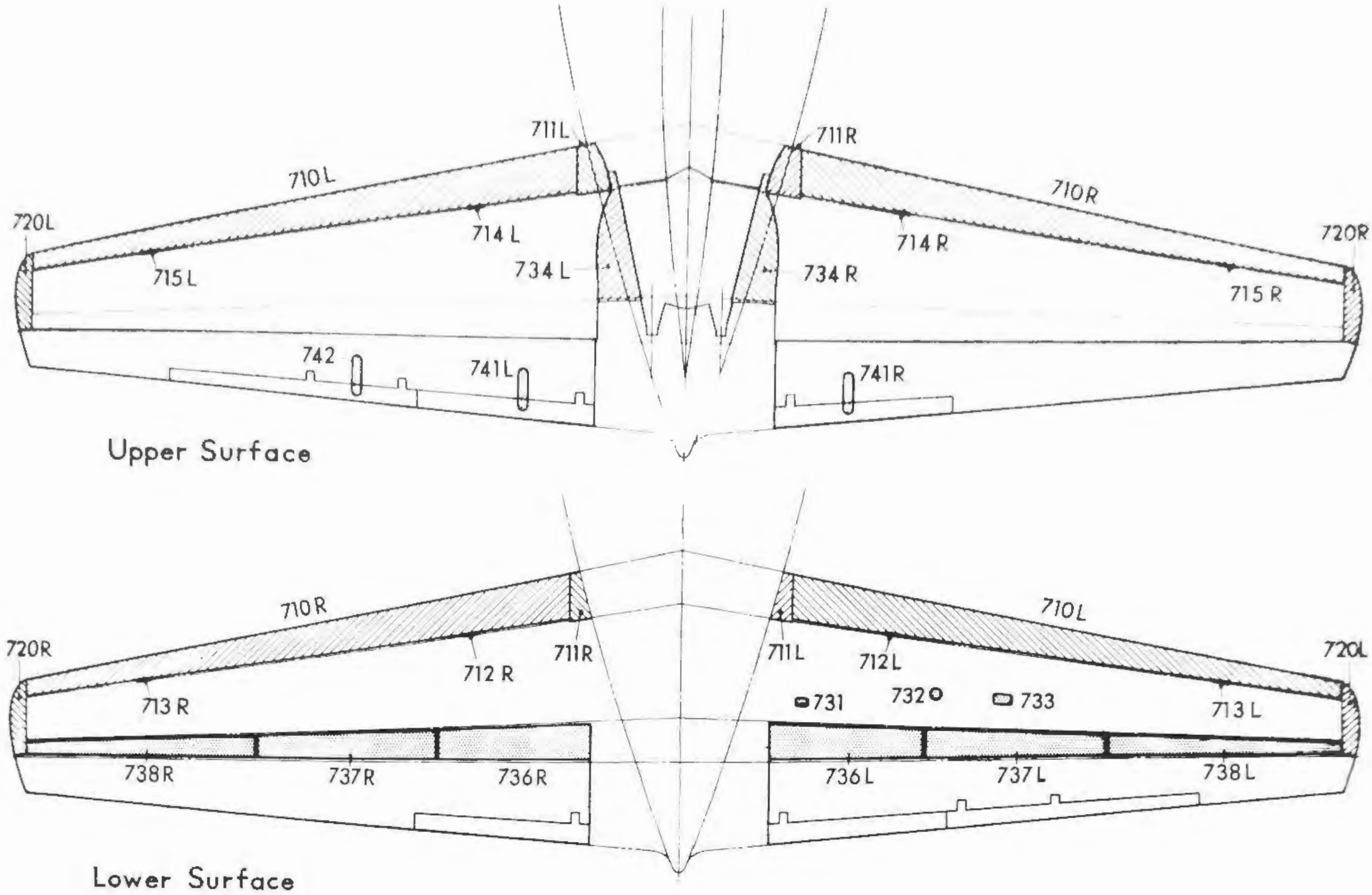
The lower side of the trailing edge forms an access door opening downward with hinges.
A vortex generator is installed in front of the door of the lower side.

The wing tips made of 6061 aluminium fabricated by welding and forming, are attached to the ends of the wings. A flux valve for the C-9 gyrosyn compass is provided in a horizontal tail wing tip.

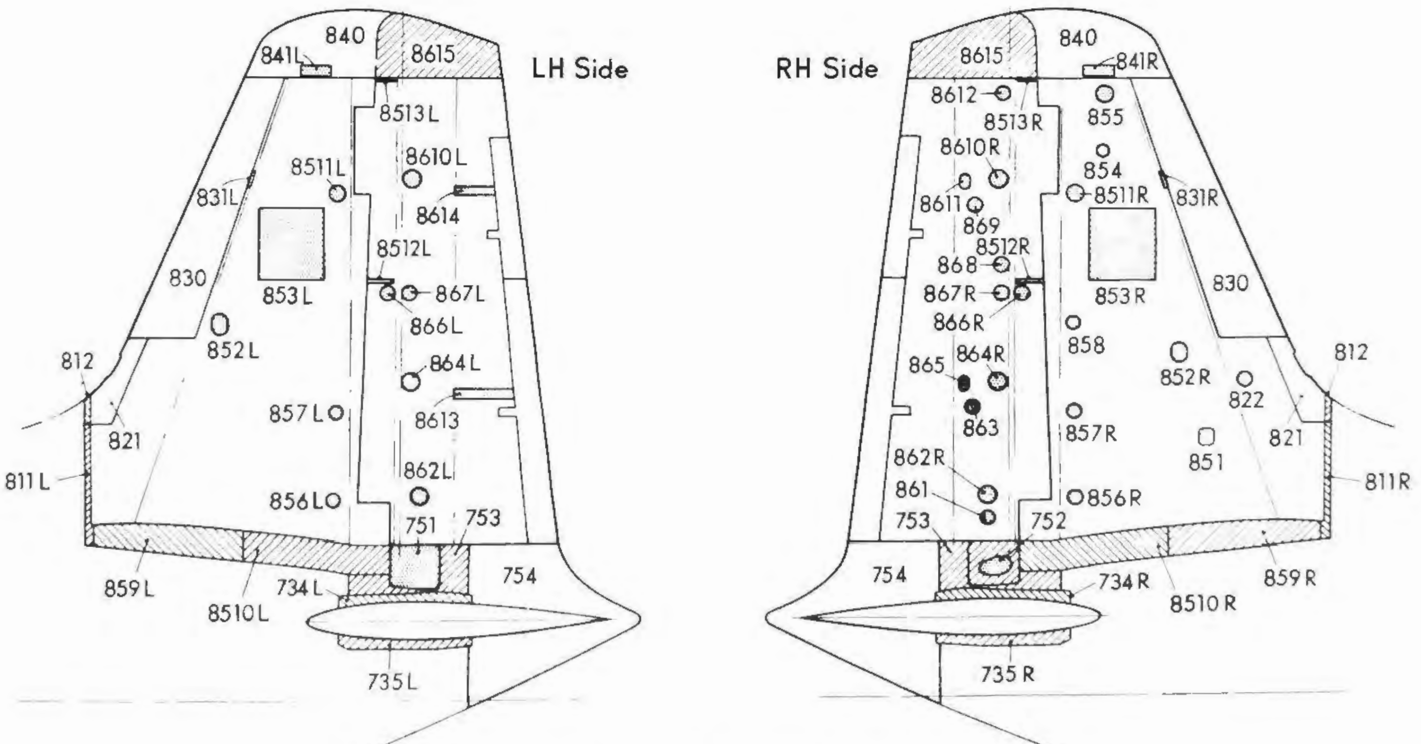
2.4.3 Elevators

The elevator, consisting of right-hand and left-hand surfaces and center torque tube, has all-metal structure except the tip.

Number	Side	Type	Purpose or Access to
8510	L, R	S	Filet
8511	L, R	S	WHF Antenna Cable
8512	L, R	S	Rudder Hinge Cover
8513	L, R	S	"
861	R	S	Rudder Spring and Trim Tab Linkage
862	L, R	S	"
863	R	S	Rudder Lower Spring and Trim Tab Push Pull Rod
864	L, R	S	"
865	R	S	"
866	L, R	S	Rudder Hinge and Idler Arm
867	L, R	S	"
868	R	S	"
869	R	S	Rudder Lower Spring and Trim Tab Push Pull Rod
8610	L, R	S	"
8611	R	S	"
8612	R	S	Rudder Hinge
8613	L	S	Rudder Spring and Trim Tab Rod Cover
8614	L	S	"
8615		S	Rudder Tip



Horizontal Tail



Vertical Tail

Tail Plane Access Plates

Figure 2-19

The hinge points are at the horn fittings at H. Sta 5850, 3800, 1400 and 300.

Balance weights are mounted on the leading edge to keep the moment at 100 ± 25mmKg (nose-heavy) in the static condition.

The clearance between the elevator leading edge and the stabilizer rear spar is sealed with curtain seal.

There are balance tabs and trim tab, the former being inside the surfaces of both sides, and the latter outside the surface of the left side.

The tab hinge points and the moments in the static condition are:

Balance tab:	H. Sta 2 400, 1 600, 800	8 ± 3 mmKg (nose-heavy)
Trim tab:	H. Sta 4 600, 3 995, 3 200	$5 \pm {}^{0}_{5}$ mmKg (nose-heavy)

2.4.4 Vertical Stabilizer

The vertical stabilizer has two-spar structure, with the front and rear spars located at 18% and 60% of the wing chord respectively. The leading edge assembly is connected to the front spar with stainless steel wire. A rubber boot anti-icing system is provided in the leading edge assembly.

The vertical stabilizer is attached to the fuselage with joint fittings on the front and rear spars by means of two taper bolts and sleeves at the front and two tension bolts at the rear. Between the spars, "J"-section longerons extend in the longitudinal direction. The stabilizer is faired with 19 ribs. The trailing edge has a fairing sheet contributing to the performance and aerodynamic effect of the rudder. Rudder hinge fittings are installed at three points.

At the center, the stabilizer is hollowed to contain a VOR antenna, which can be inspected and serviced from both sides. The tip is covered with fabric reinforced plastic molding. A VHF antenna adjuster is installed inside the tip.

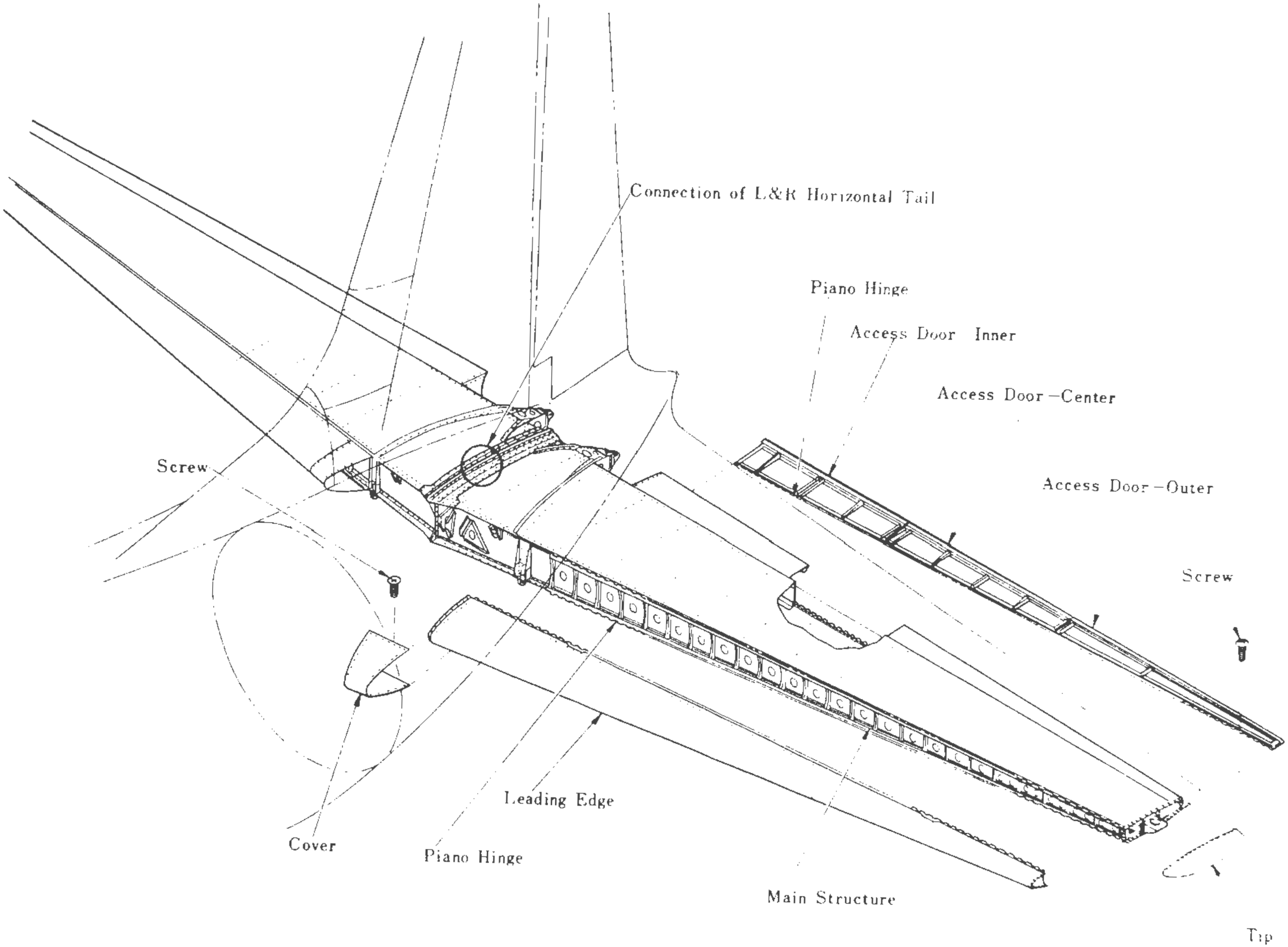
2.4.5 Rudder

The rudder has all-metal structure except its top which is made of fabric reinforced plastics. At the lower end, it has a torque tube and a quadrant with a tension regulator.

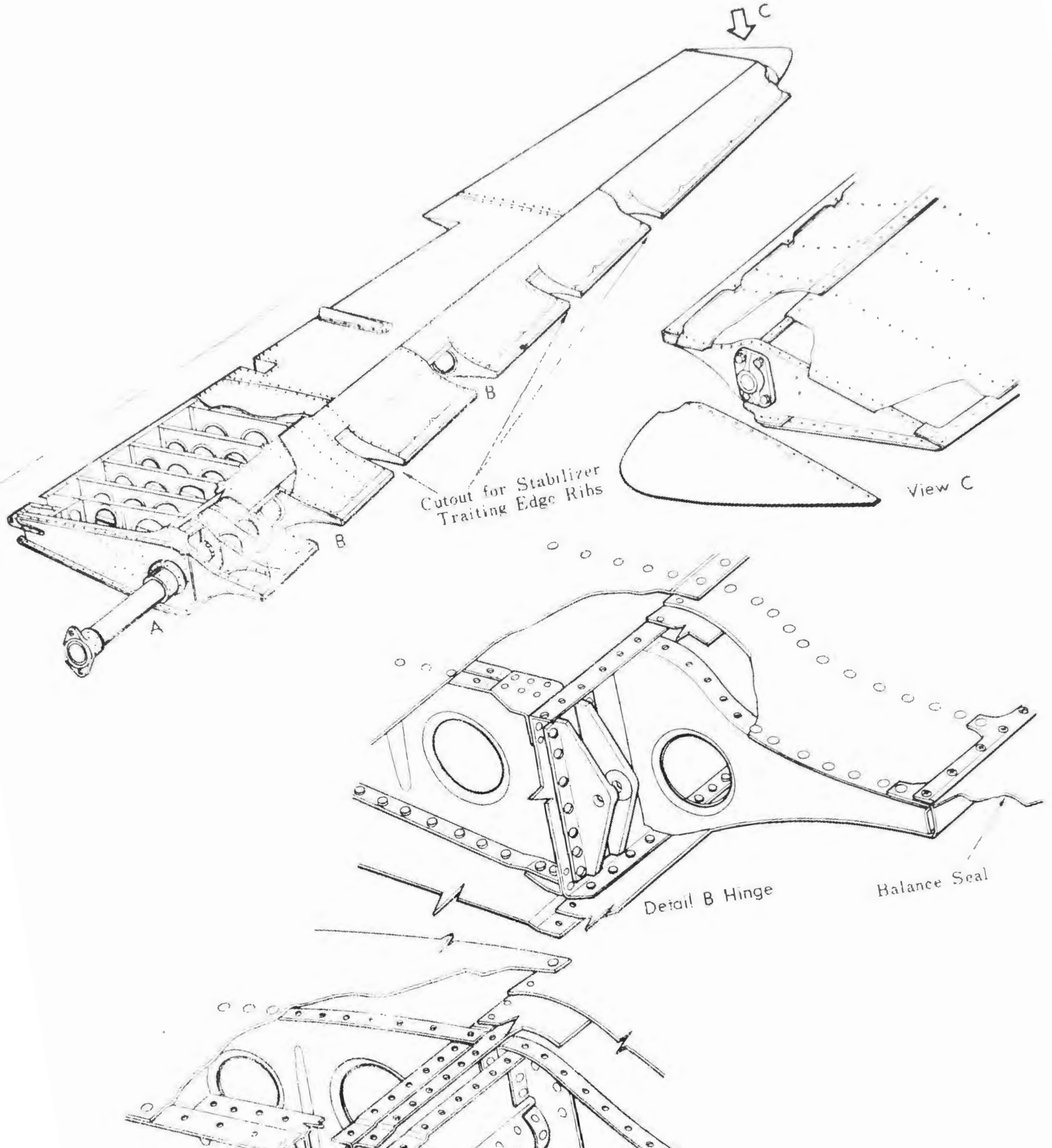
Rudder attachment hinges are provided at three points (V Sta 4000, 2250 and -170).

The hinge at V Sta -170 takes load in the direction of hinge line. Balance weights are distributed in the balance horn in the section between V. Sta 3750 and 3000 of the leading edge and in the lower part of the leading edge.

Two pairs of upper and lower tabs, serving both as springs and as trim tabs, are provided on the trailing edge at the following locations:



Horizontal Stabilizer Components
Figure 2-20

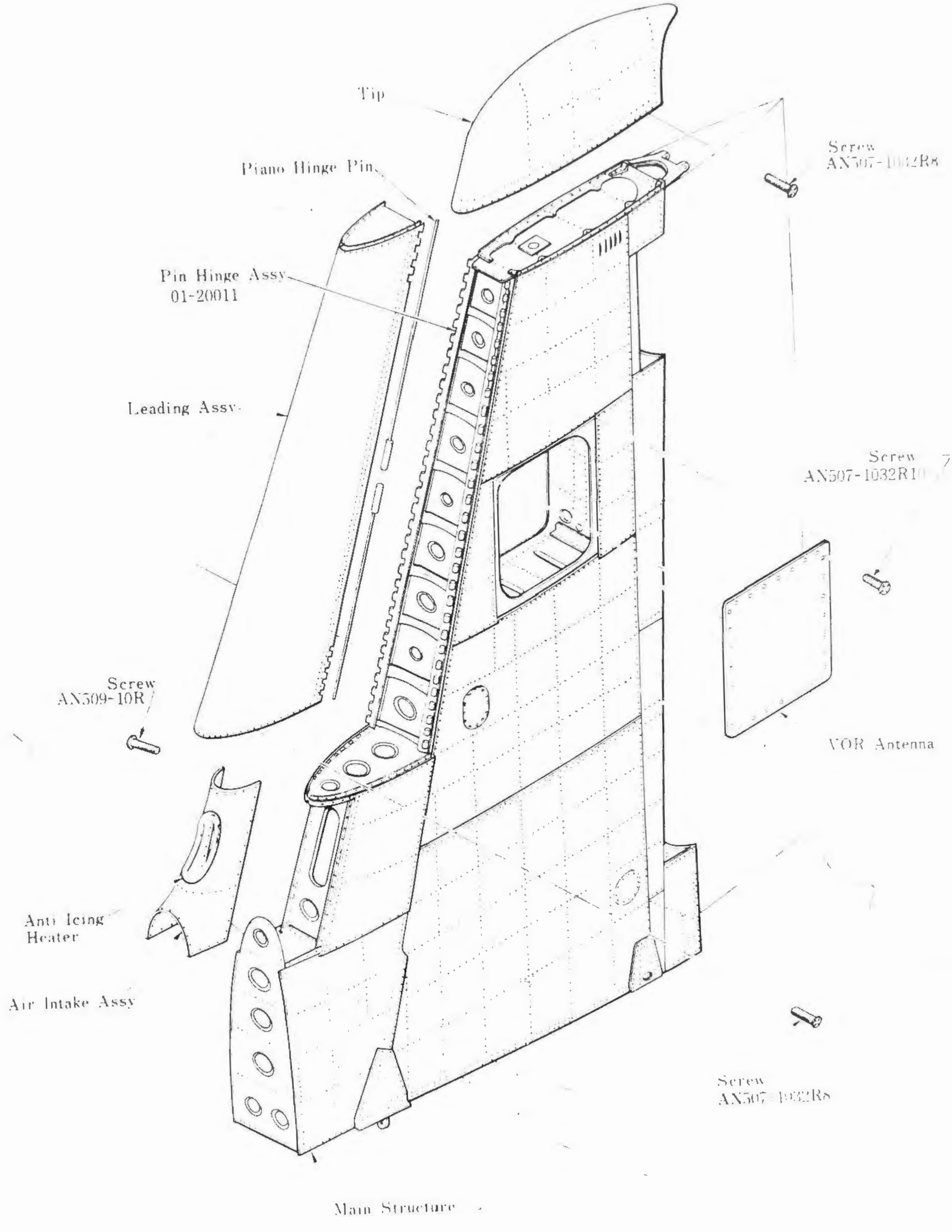


Elevator Structure
Figure 2-21

Upper spring and trim tab:	V. Sta 3250 and 2500
Lower spring and trim tab:	V. Sta 2000, 1000 and 0

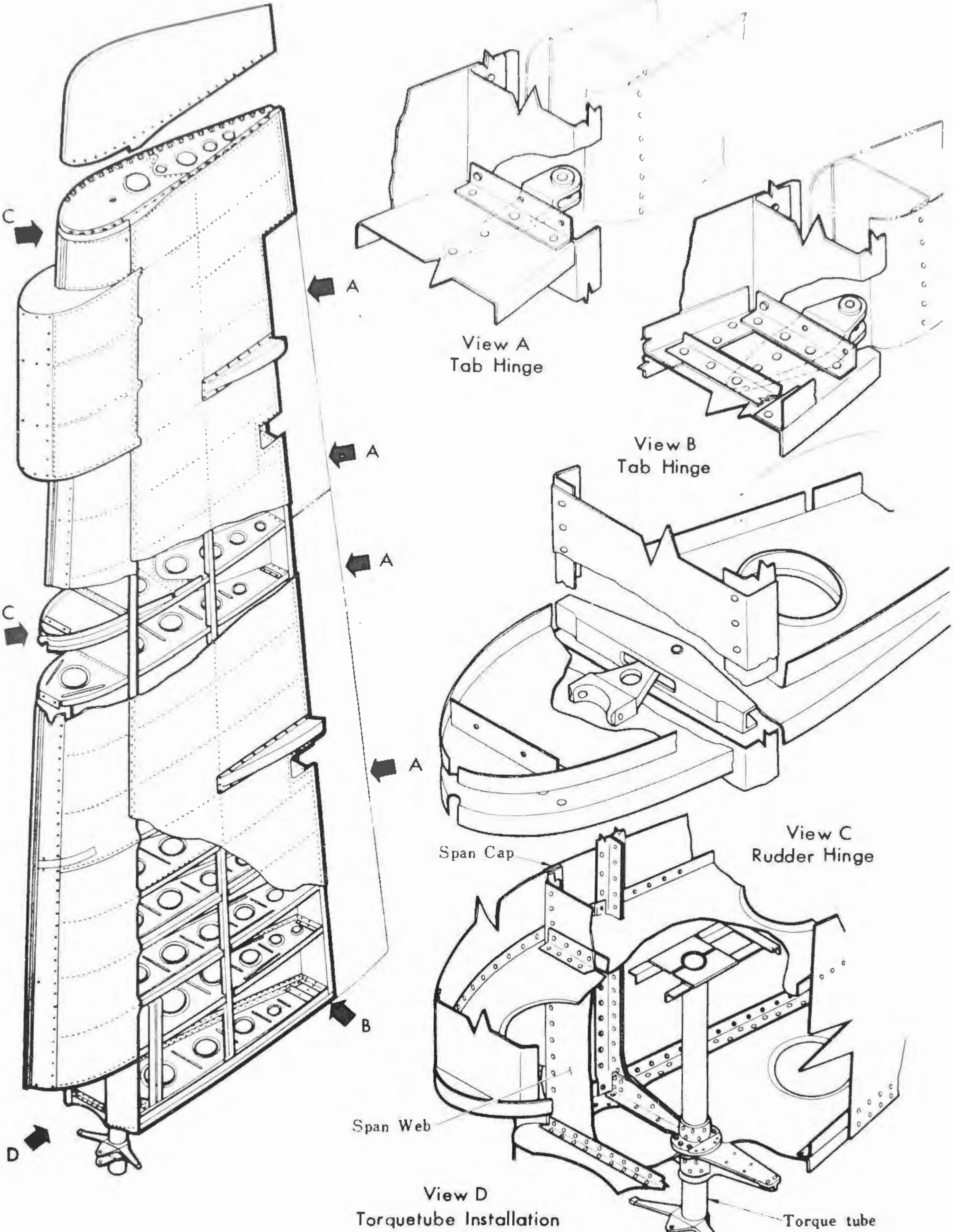
Two static dischargers are provided in the upper part of the rudder. Throughout the top of the leading edge of the rudder, rubber molding for sealing is provided to minimize the clearance between the leading edge of the rudder and the trailing edge of the stabilizer. Moments in the static condition are:

Rudder:	1,000 ± 100 mmKg (nose-heavy)
Lower tab:	12 ± 3 mmKg (nose-heavy)
Upper tab:	7 ± 3 mmKg (nose-heavy)

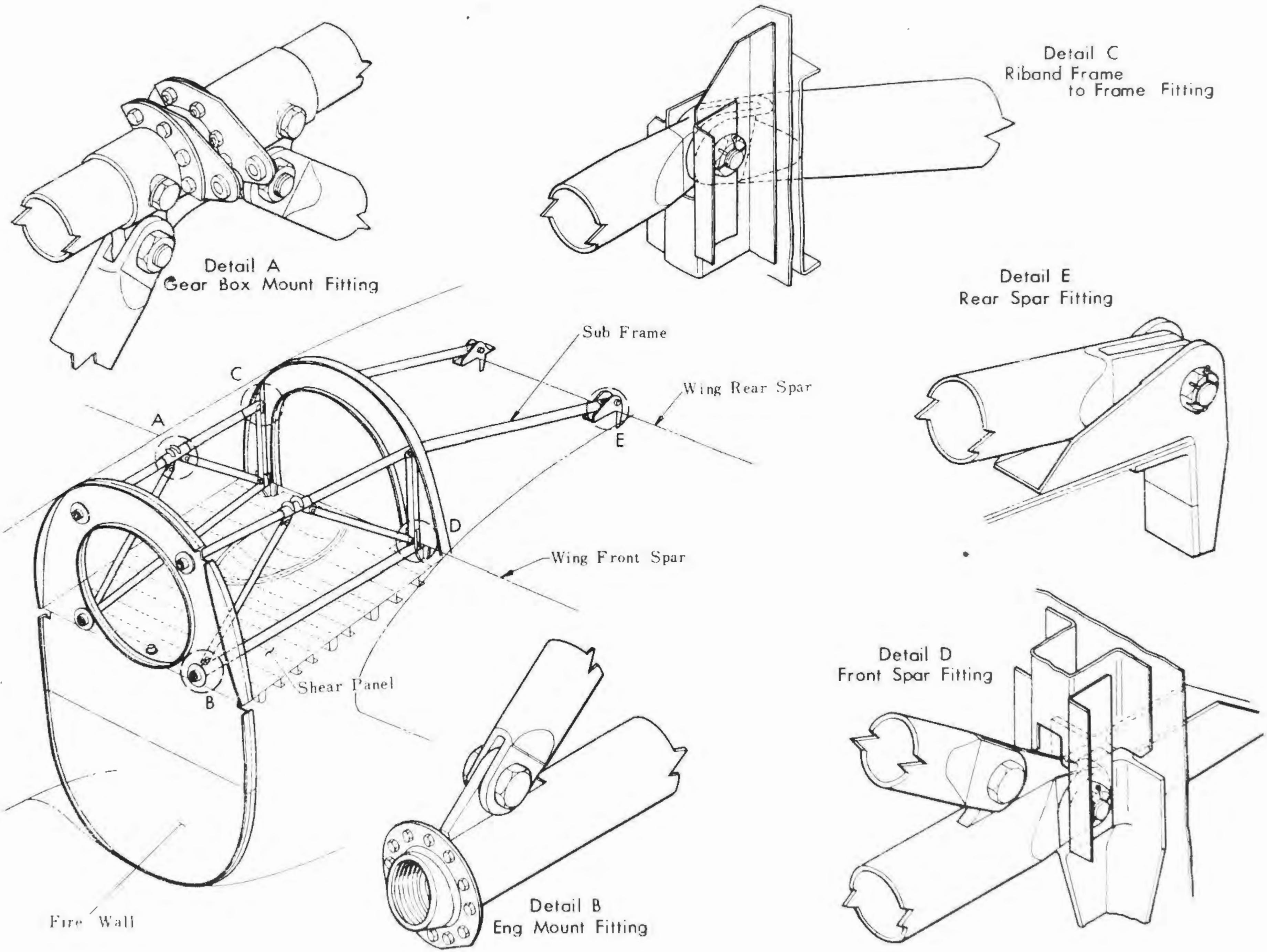


Vertical Stabilizer Components

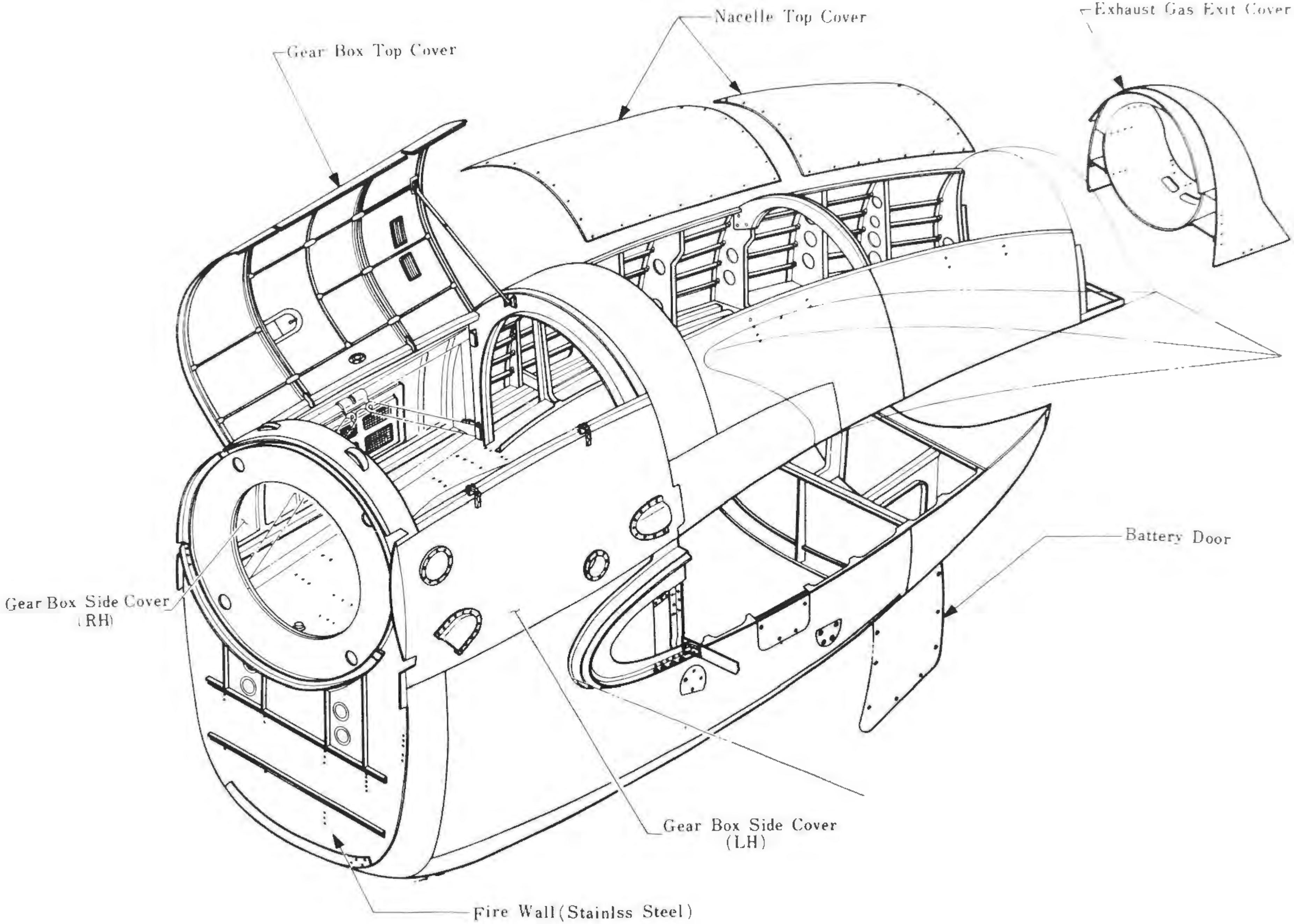
Figure 2-22



Rudder Structure
Figure 2-23



Nacelle Main Frame
Figure 2-24



Nacelle Covers
Figure 2-25

2.5 Nacelle

2.5.1 General

Each nacelle is all-metallic, and is permanently fixed to the outer wing. It consists of main structural elements such as a firewall, sub-frame and shear panel, and auxiliary structural elements such as ribs, stringers, skins and covers.

The sub-frame is bolted to the spar-to-spar structure of the outer wing, with its forward end connected to the engine mount through the firewall.

Engine exhaust pipe penetrates the upper part of the nacelle to its aft end. An accessory drive gear box is installed above the said part.

The lower part of the nacelle constitutes a space to house the main landing gear and the batteries.

On both sides in the rear of the nacelle firewall and on its back, there are detachable covers, five in all.
FRP-made fillets for fairing are fixed on both sides of the rear of the nacelle.

2.5.2 Material for Structure

The sub-frame is made of ten 4130 steel tubes, and is connected to the front and rear spars of the outer wing through fittings at W.S. 2482 and W.S. 3334. The engine mount is installed on the forward end of the sub-frame through the firewall.

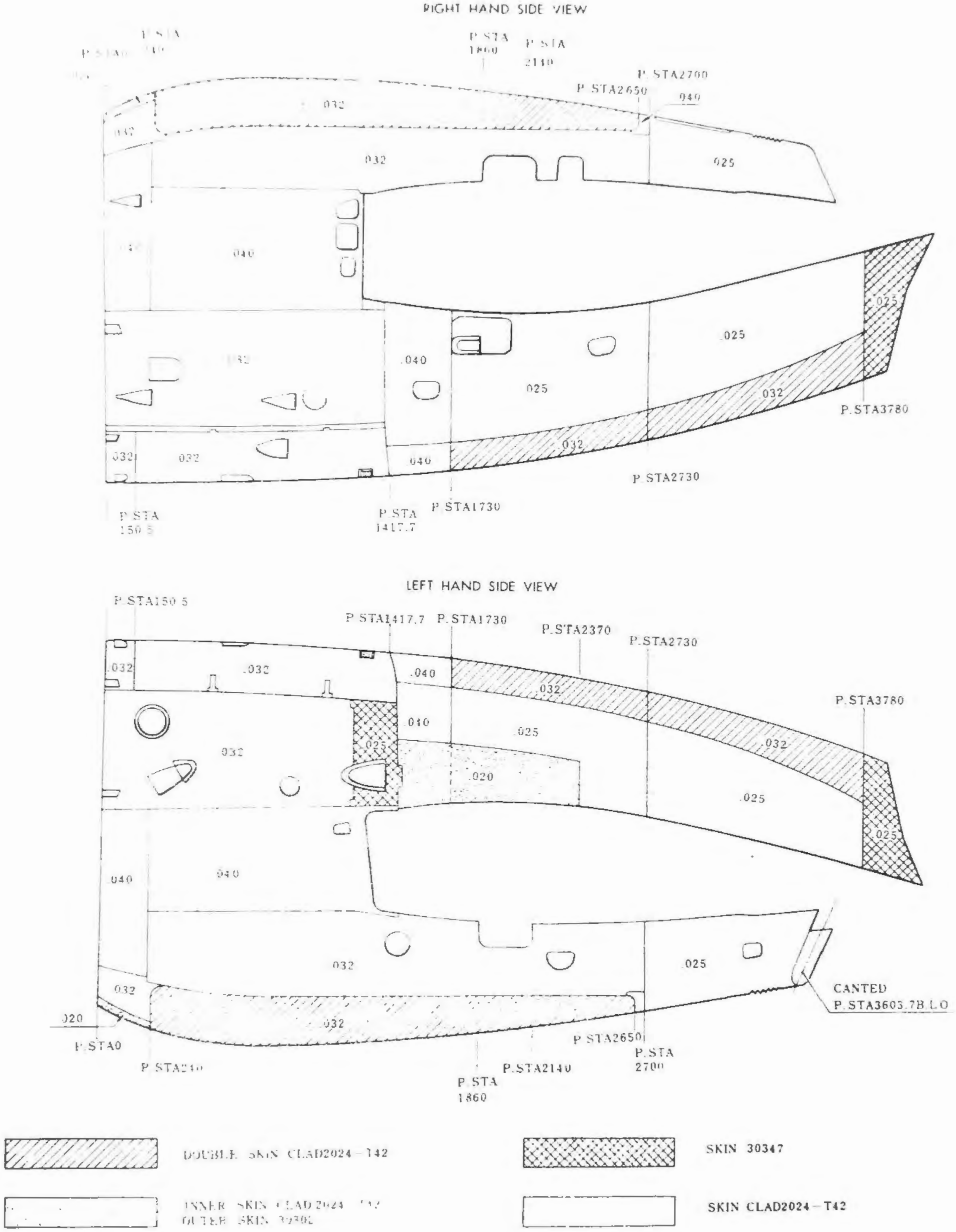
The sub-frame has fittings at its center to install the gear box.
End fittings are welded to the joint portion of the frame.

The firewall consists of webs made of 30302 stainless steel 0.025 inch and 0.50 inch in wall thickness and ribs made of 30347 material. The wall has hinge fittings for the cowling, and is penetrated by the power control units and fuel piping.

The shear panel, made of 2024-T3 material, is in the lower part of the sub-frame. It is riveted to the firewall, the ribs in the upper part of the front spar and the skin.

The sub-frame is fixed to the arch-shaped ribs in the upper part of the front spar. The lower ribs have landing gear door center hinges.

The filets, made of FRP, are fixed to the nacelle skin and the main wing upper skin with screws.
Fig. 2-26 shows the material and thickness of the skin.



Nacelle Skin and Doublers

Figure 2-26

2.6 Door

2.6.1 General

The pressurized portion of the fuselage has the doors listed in Fig. 2-28 All those doors open outward. When the doors are closed, airtightness is maintained by the rubber seals attached to the doors and the strikers on the fuselage side. The following table shows the dimensions of each door and the number of its latches:

Name of door	Number of latches or hooks	Dimensions (m)
Main Entrance	9(Latch Rod)	1.60 x 1.00
Service	6(Latch Rod)	1.22 x 0.64
Foreward Cargo	6(Latch Rod)	1.25 x 0.84
Aft Cargo	6(Latch Rod)	1.22 x 0.80
Emergency Exit	4(Latch Rod)	0.73 x 0.48
Electric Access	2(Hook)	
Belly Cargo	2(Hook)	
Flight Control Access	2(Latch Rod)	
Hydraulic Access	2(Latch Rod)	
Air Cond. Access-Fwd	2(Latch Rod)	
Air Cond. Access-Aft	4(Latch Rod)	

* As to Main Entrace Door, refer to Chapter 6, HYDRAULIC SYSTEM.

2.6.2 Cabin Door

(1) General

On the floor of the fuselage are main entrance door, forward cargo door, service door and aft cargo door. Of those doors, the latter three have the same structure and the same locking mechanism. (As to the main entrance door, refer to the chapter on hydraulic system.)

The said three doors employ double hinges which permit them to open outward by 180°. The doors can be opened and closed either from the outside or from the inside of the aircraft (the forward cargo door, from the outside only).

(2) Latching Mechanism

When the door is closed, six latch rods are inserted into the air-frame side and lock the door. The latch rods take the pressure in the fuselage; the hinges take no load.

The handle open lock mechanism prevents the door from moving from the open position to the close position while the latch rods remain extended. That is, once the handle is set to the "open" position,

it cannot be brought to the "close" position until the door takes the "close" position.

The hold open mechanism locks the door at the "open" position by interlocking the hooks on the door side with the claws on the airframe.

The handle mechanical lock mechanism prevents the door from opening by mistake during flight.

With the handle set to the "close" position, the end of the interior handle automatically catches the handle lock lever.

Consequently, the handle cannot be moved unless the handle lock lever is pushed downward.

(3) Differential Pressure Lock

The differential pressure lock has a pressure locking claw which fixes the handle lock lever in the lock position according to the movement of a diaphragm which senses the pressure difference between the inside and the outside of the cabin.

The diaphragm begins to move at 0.2 psi. min., and completes its movement at 0.4 $\pm$ 0.1 psi max.

2.6.3 Emergency Exit Door

The emergency exit door opens outward together with the window frame. Door operating handles are provided both inside and outside the aircraft; so the door can be opened either from the inside or the outside.

This door also has a differential pressure lock mechanism which prevents the door from opening during flight.

The door is piano-hinged at its bottom.

2.6.4 Underfloor Access Hole and Door, and Inspection Hole

Each door is supported with two piano hinges.

The doors of the belly cargo compartment and the electric compartment have handles on their external sides. They can be locked with two latch hooks.

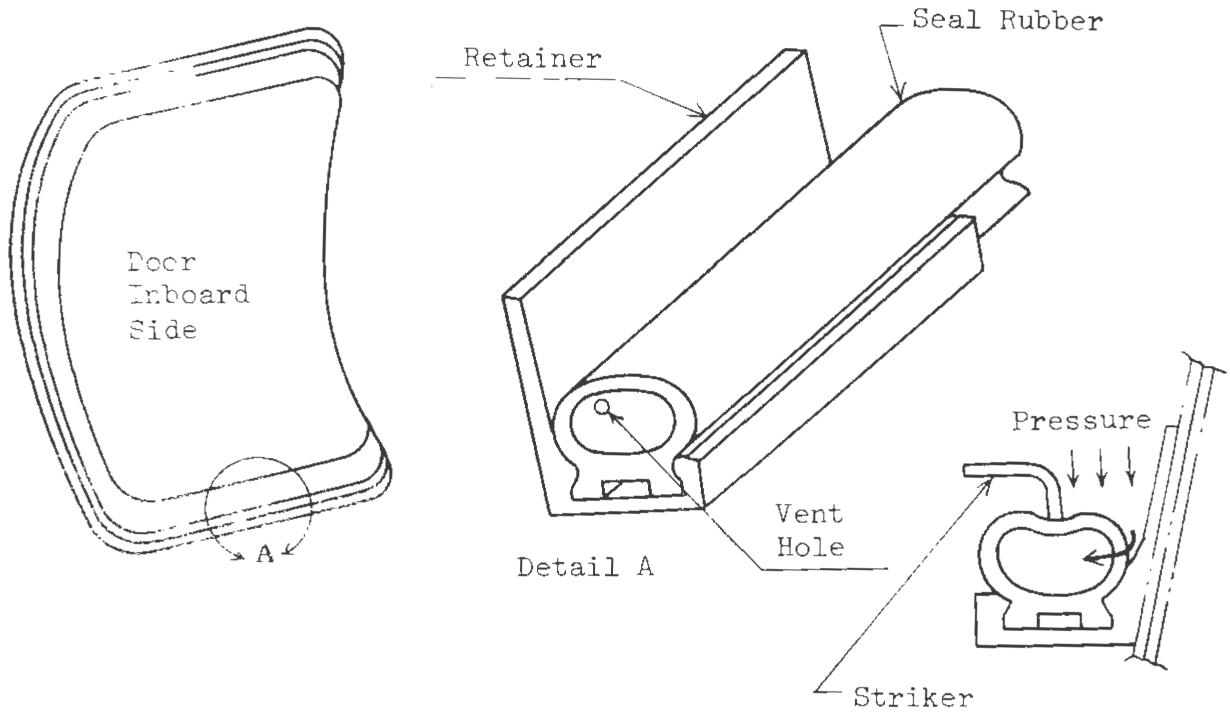
The door actuating mechanism unlocks the hook when the door handle is placed in the "open" position and automatically locks it with spring force when the handle is placed in the "close" position.

The doors of the flight control, hydraulic and air-conditioning compartments are locked by bayonets.

On the inspection hole in the aft fuselage which is not pressurized, an ordinary access panel is attached with fasteners.

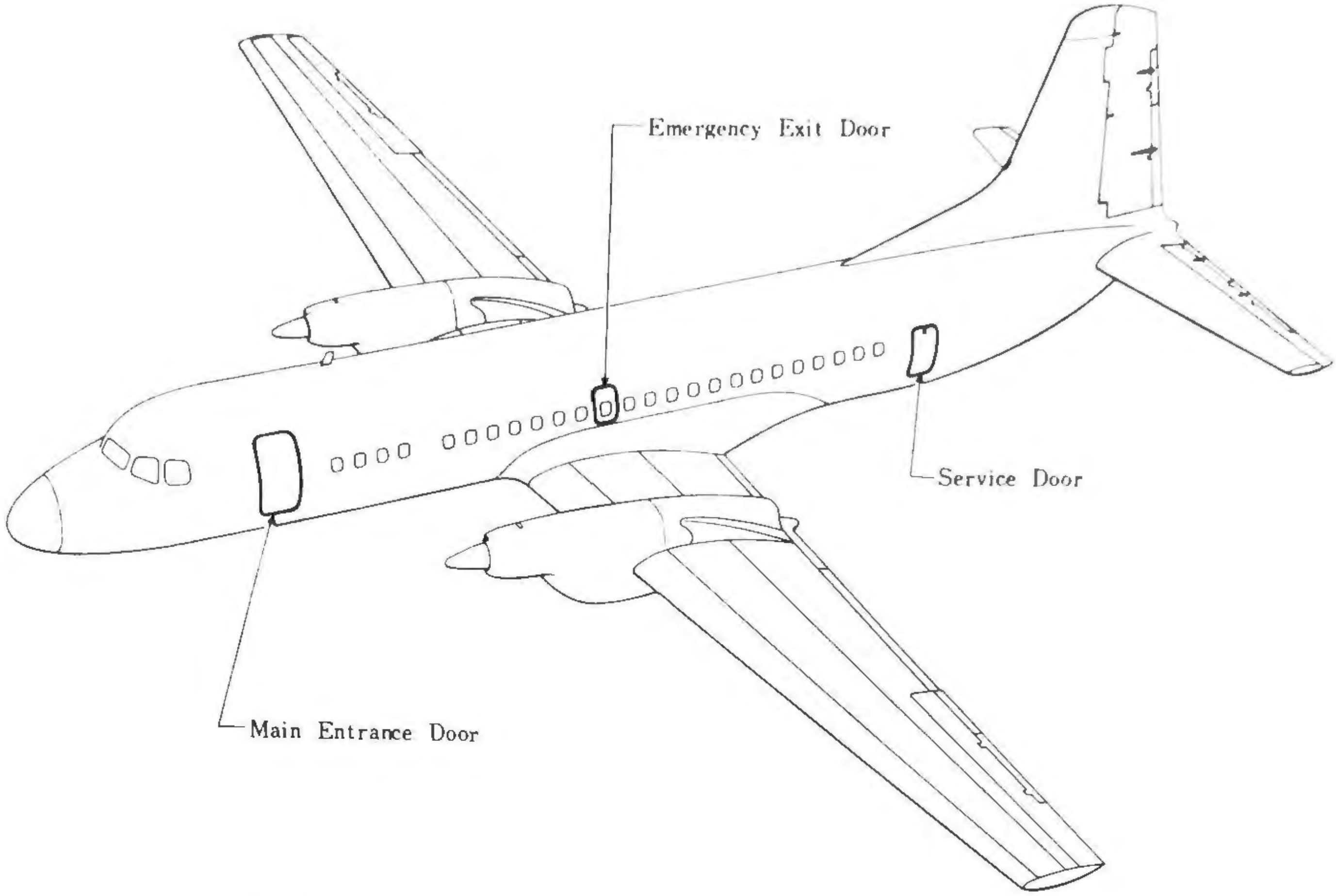
The inspection hole of the center wing is on the flight control compartment side. The cover of this hole is secured by screws, and is pressure-sealed with sealing material.

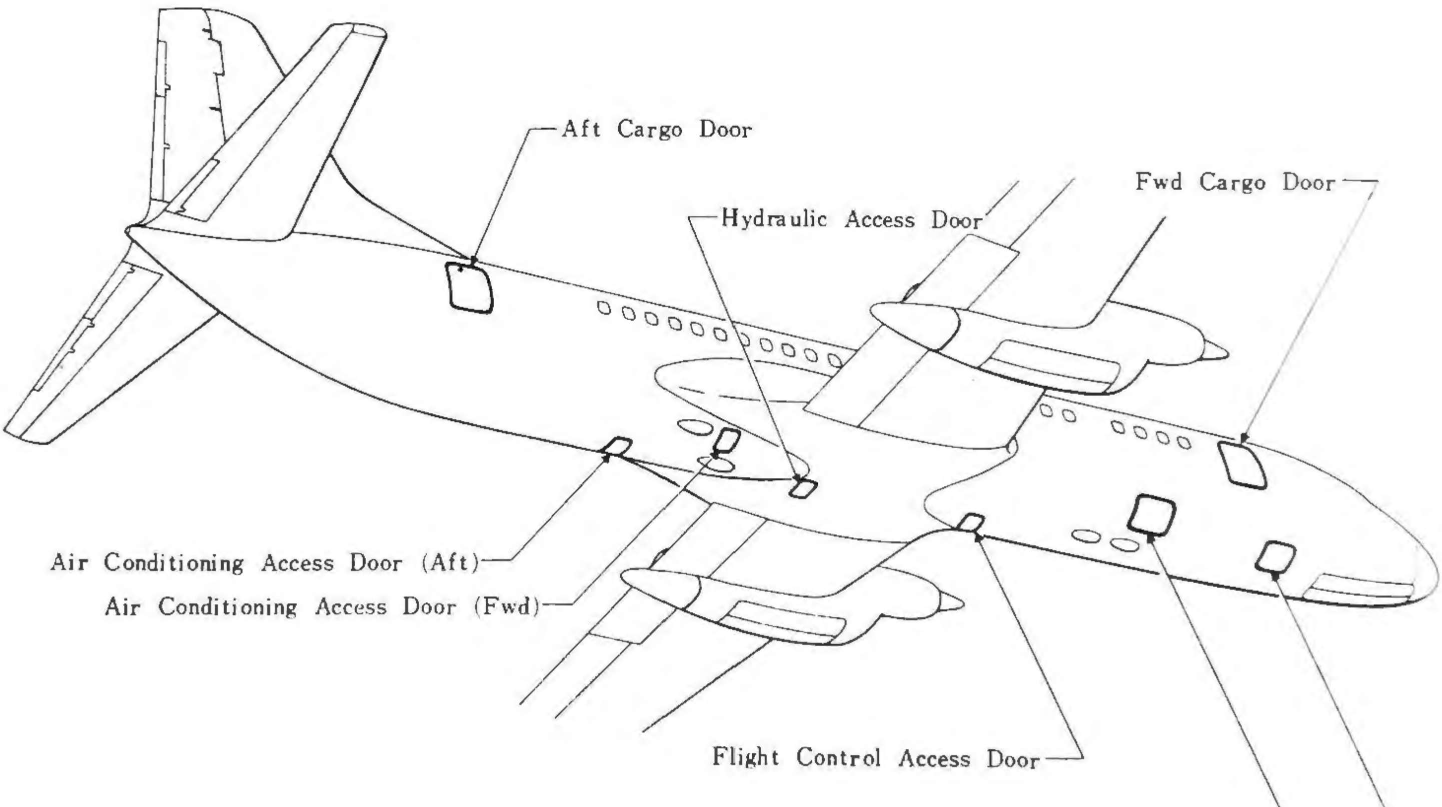
<u>NOTE</u>: As to the warning system, refer to Section 6.6 Stairway System.



Door Seal

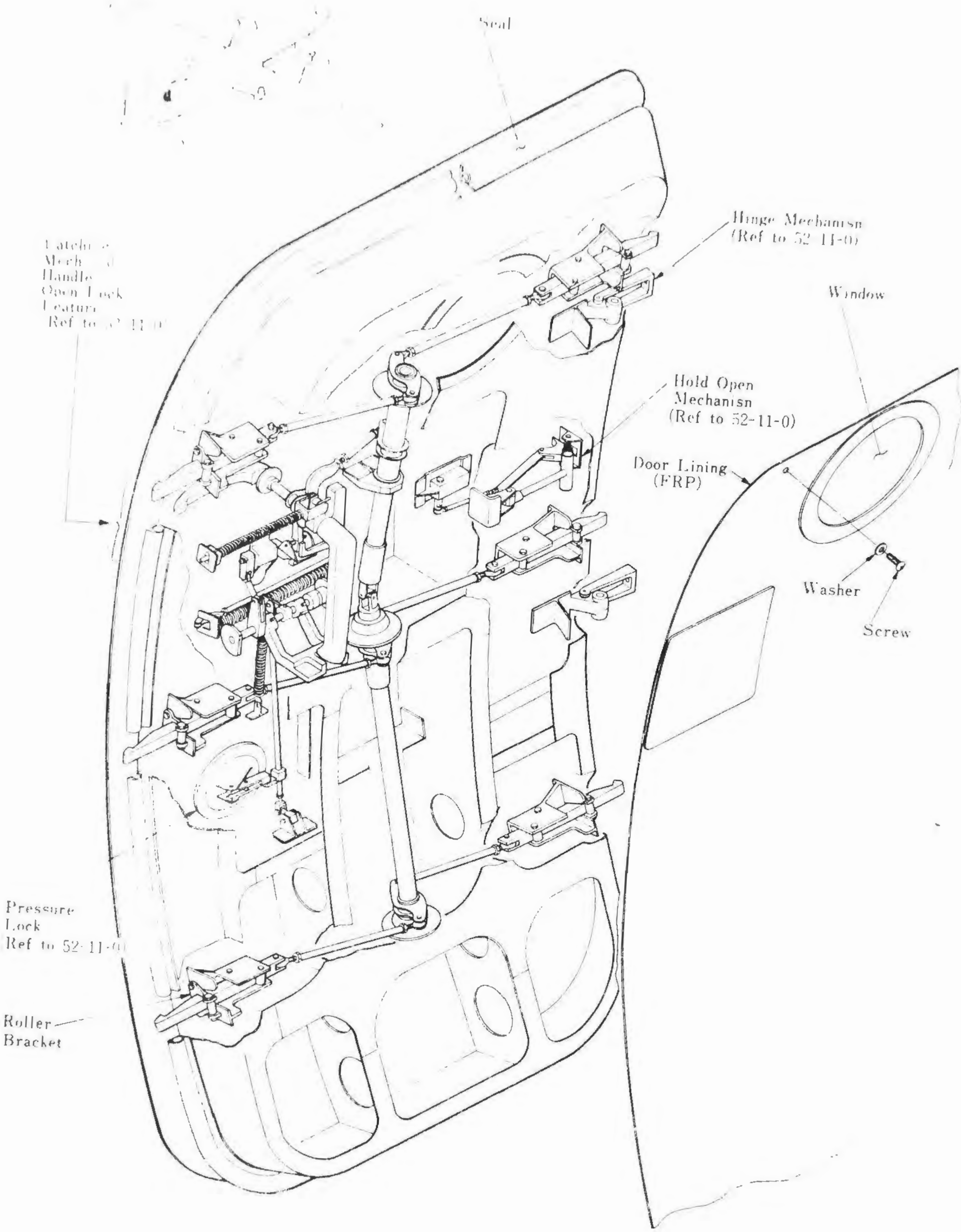
Figure 2-27





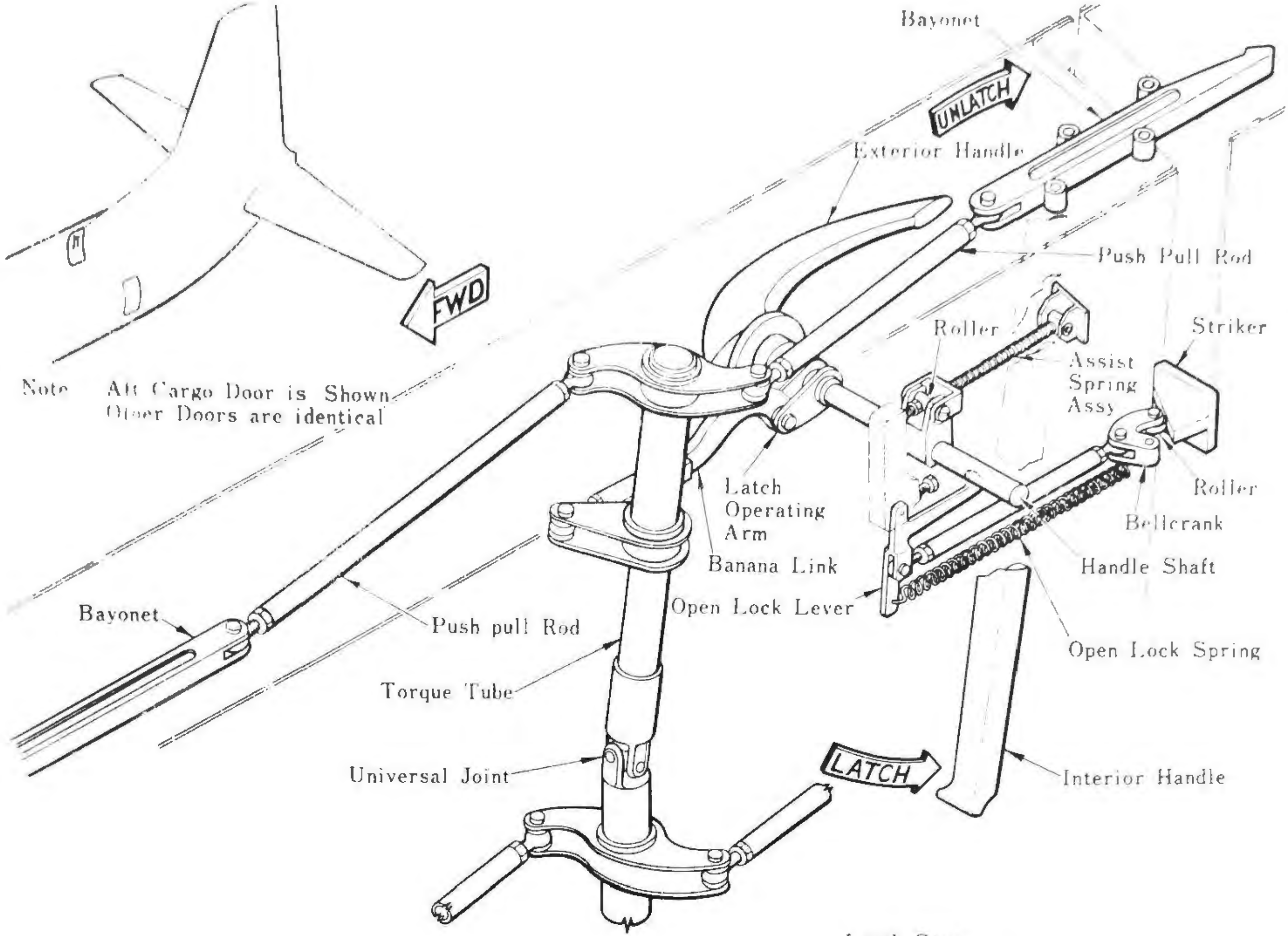
Fuselage Door

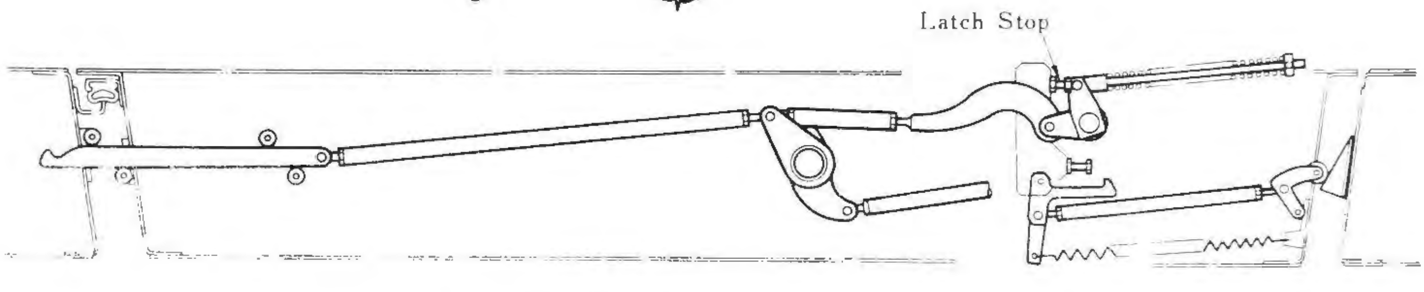
Figure 2-28



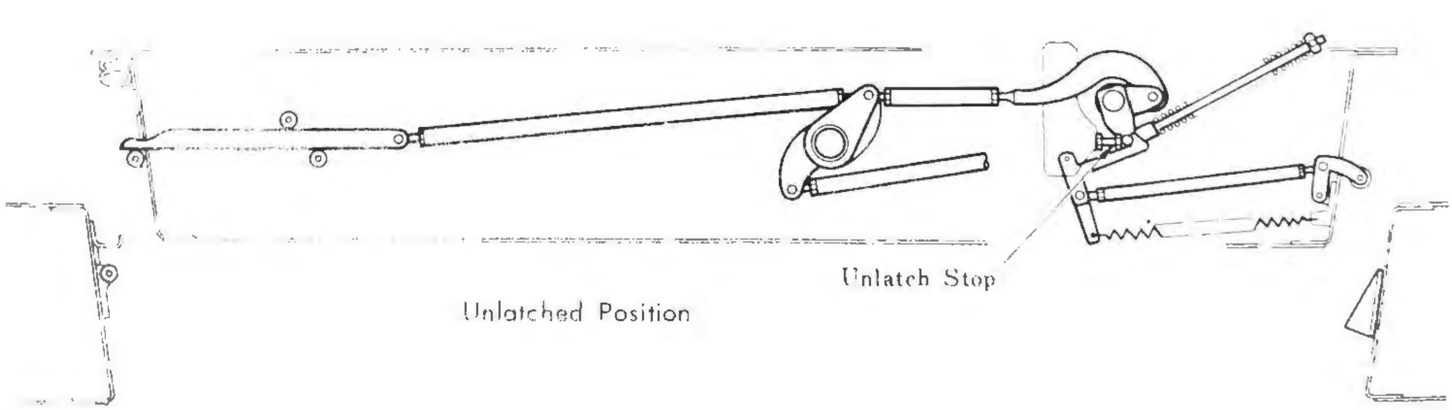
Galley Service Door

Figure 2-29





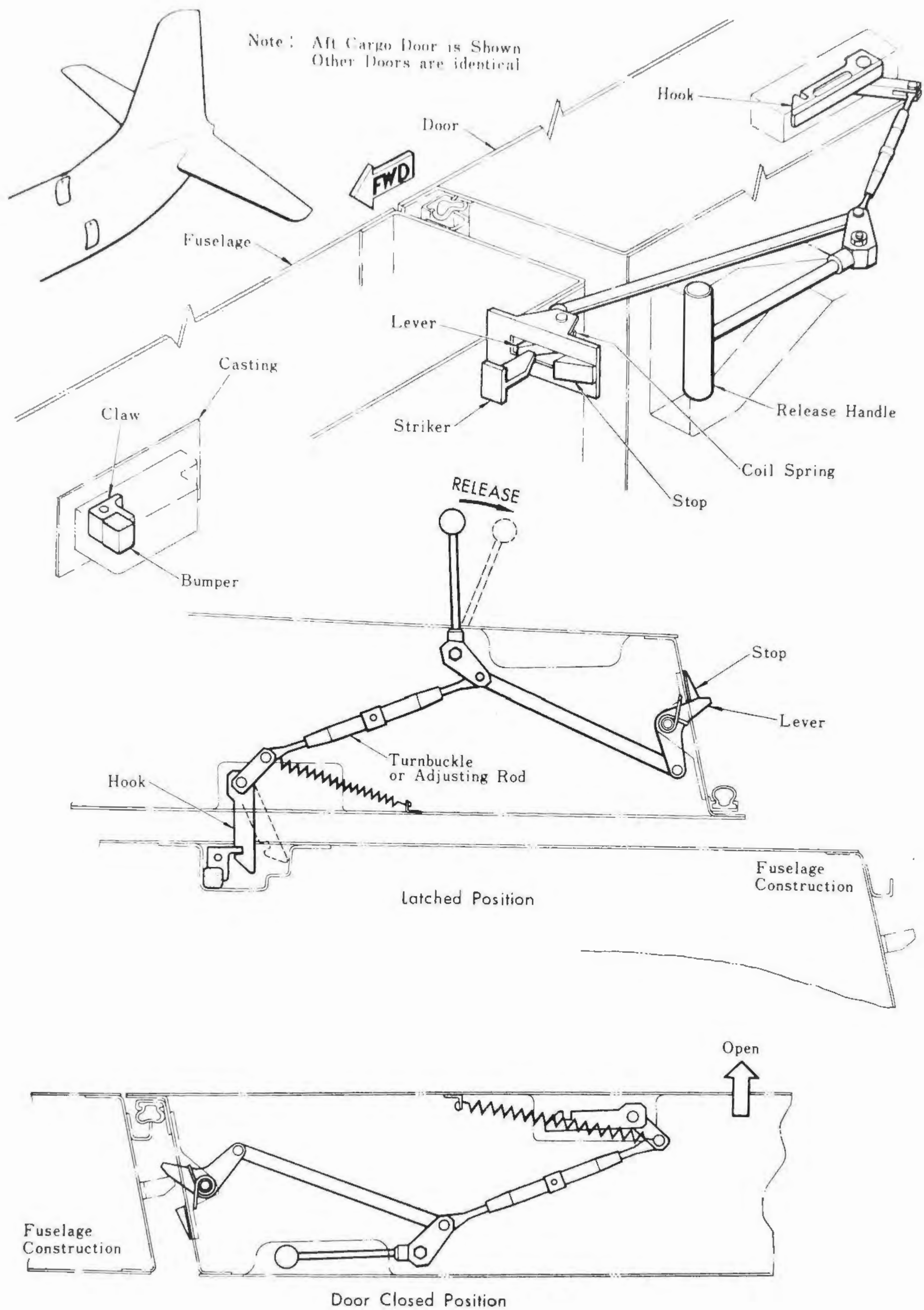
Latched Position



Unlatched Position

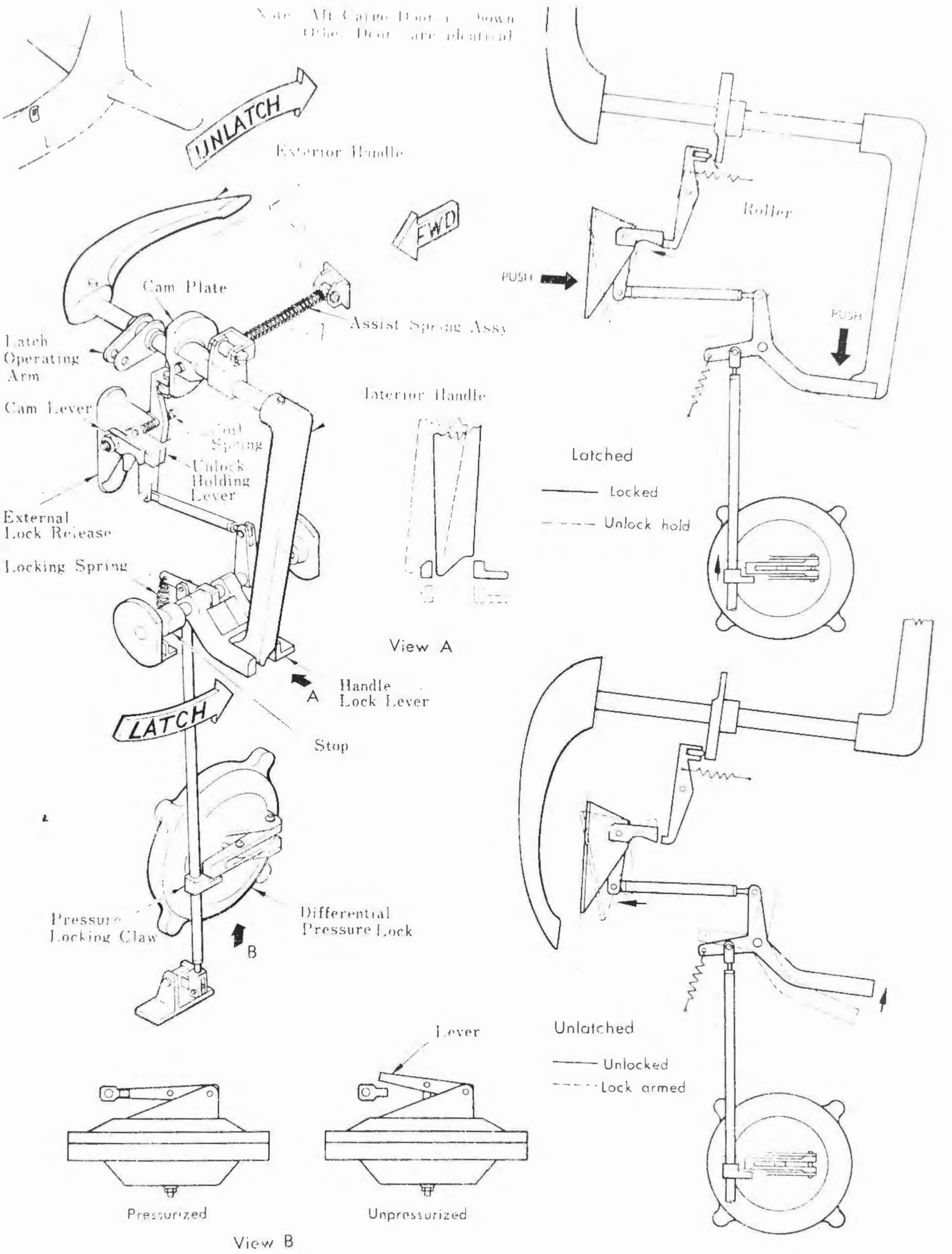
Latching Mechanism

Figure 2-30



Hold Open Mechanism-Door

Figure 2-31



Pressure Lock Mechanism

Figure 2-32

2.7 Windows

The windows are classified into cockpit windows and cabin windows. The former are forward windshield, sliding window shield and aft windshield.

The number of the latter, including emergency exits, is 25 on the L.H. side and 26 on the R.H. side. A small round window is provided above each door.

2.7.1 Cockpit Windshield

Three kinds of cockpit windshields, six in all, are provided. The forward windshield is made of laminated reinforced glass panel with electro-conductive coating inside the panel. The panel is heated for deicing and defogging and for protection against birds.

The sliding windshield consists of double panels, the outer panel being made of laminated reinforced glass; and the inside, acryl plastics. The air layer between the panels prevents the window from fogging. The windshield can be opened only when the compartment is not pressurized. Each windshield is explained below in some details:

(1) Forward Windshield

The forward windshield has sandwich structure with a vinyl layer placed between two reinforced glass panes.
The inside pane which is called the main ply, is 8 mm (0.312 in) thick fully tempered glass which serves as main structural member of the panel to withstand pressure.

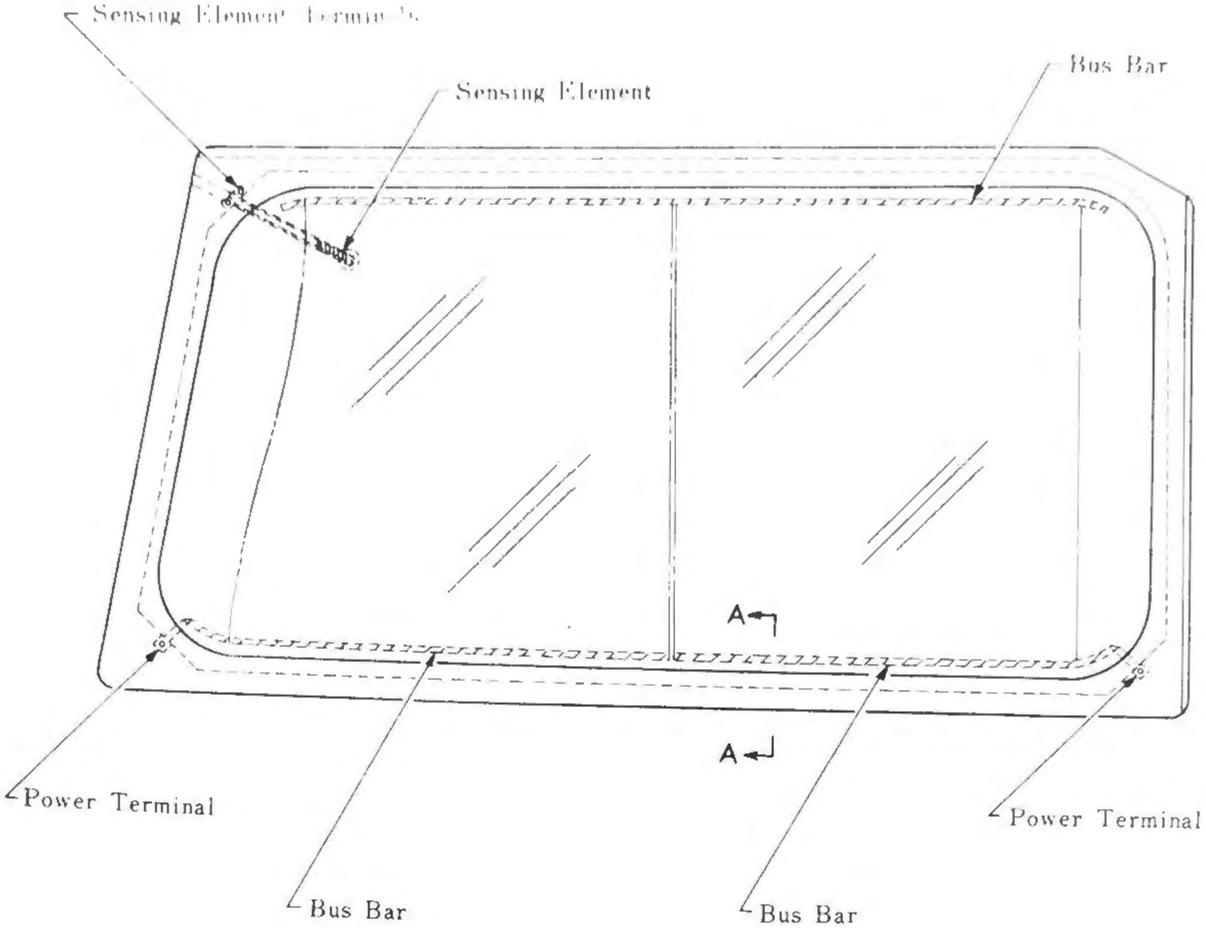
The inter-layer is 6mm(0.25 in) thick poly-vinyl butyral. When a bird hits the window, the inter-layer serves as buffer, and prevents pieces of broken glass from scattering.

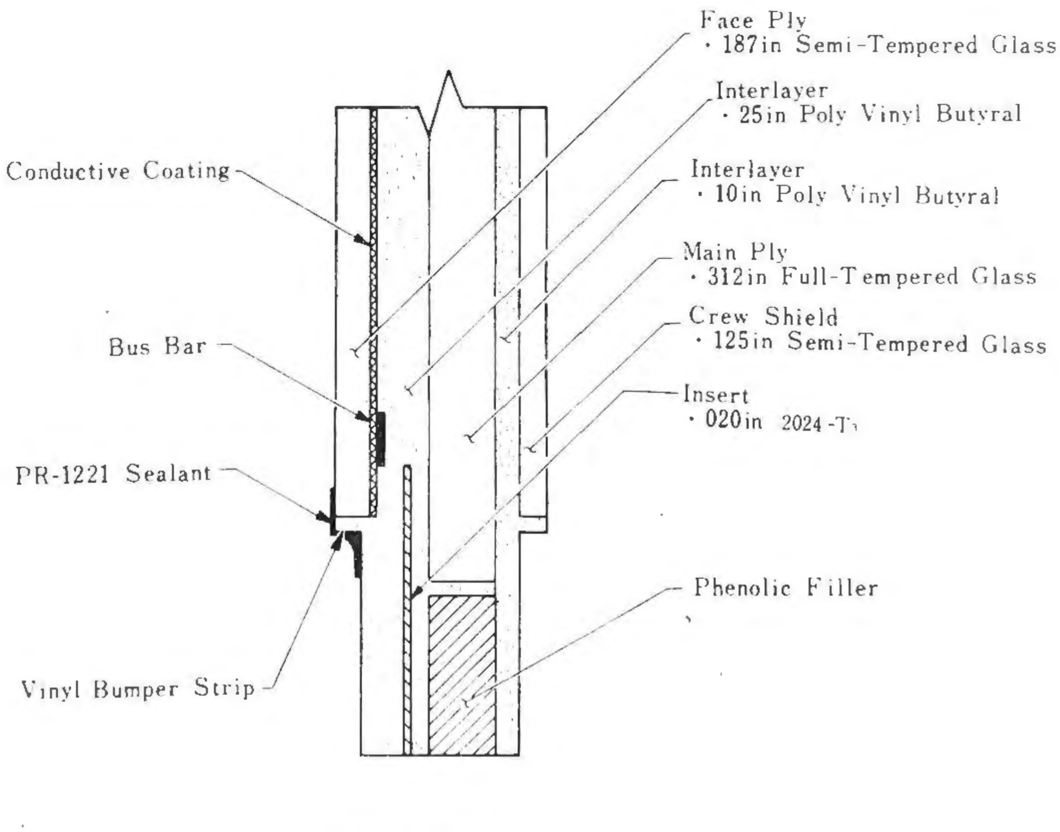
The outside pane which is, called the face ply, is 5 mm (0.187 in) semi-tempered glass with the inside coated to be electro-conductive. Bus bars are buried at the top and the bottom of the panel. If electric current is supplied to the coating, it is heated, deicing the panel and at the same time it gives plasticity to the inter-layer to absorb shocks. Also, buried in the upper portion of the center side of the panels are sensing elements which keep temperature constant.

The panels are fixed in position with screws from the outside of the fuselage. For reinforcement, therefore, a 1 mm (0.040 in) insert is buried into the inter-layer. Also, aluminium alloy bushings are provided in the screw holes to prevent the layer from being damaged because of excessive overtightening.

(2) Sliding Windshield

The sliding windshield is of dual structure consisting of inner and outer panels.





Section A-A

Forward Windshield Panel
Figure 2-33

a. Outer Panel

This panel is of dual structure with a vinyl layer placed between two reinforced glass panels. Material of each layer is as follows:

Face ply:	0.125 inch semi-tempered glass
Inter-layer:	0.200 inch poly-vinyl butyral
Main ply:	0.250 inch fully tempered glass

b. Inner Panel

This panel is 0.250 inch thick acryl plastic material. Conditioned air in the cockpit enters the portion between the aforesaid two panels through a moisture absorbing device using silica gel, defogging the windshield and insulating heat.

The sliding windshield moves on rollers along the track. In emergency, it can be opened from outside the aircraft.

(3) Aft Windshield

The aft windshield, made of acryl plastic material, is of a dual structure, composed of outer and inner panels 0.500 inch thick each. Cockpit air enters the portion between the two panels through the silica gel desiccator.

Rubber bushings are provided in the panel mounting screw holes to take the relative motion of the fuselage structure and the window and to serve as sealing.

2.7.2 Cabin Windows

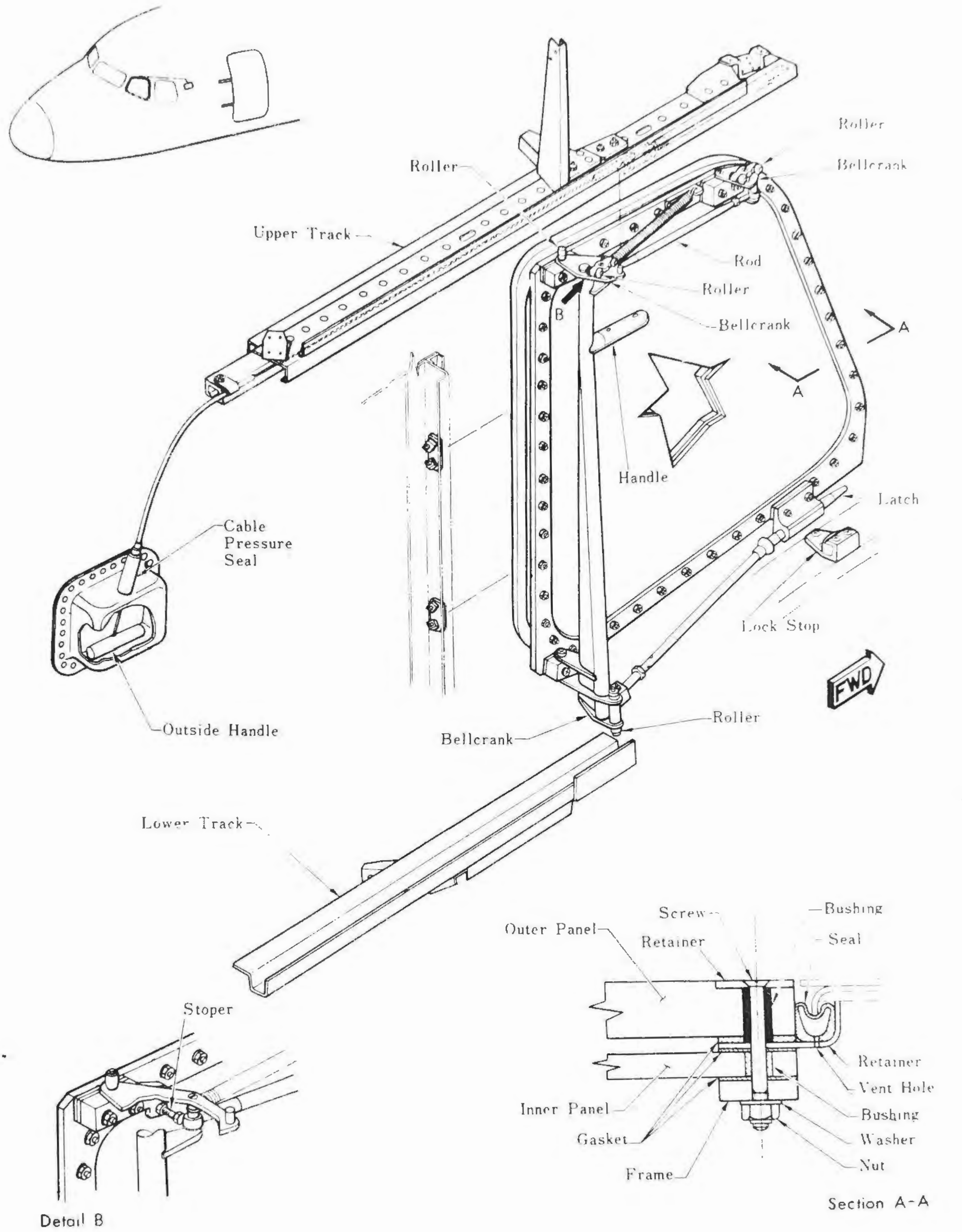
In the cabin, there are 25 L.H. and 26 R.H. windows, each 240 mm wide and 320mm high.
The cabin window is of dual structure consisting of outer and inner panels which are 5 mm thick acryl plastic panes. The air layer, which is formed by spacers made of the same material as the panels, defogs the window and provides heat insulation for the cabin.

The aforesaid air layer is connected to the vinyl bag of the desiccator through the silica gel-filled vinyl tube for desiccation which is in the lower part of the window.

As the vinyl bag transmits the cabin pressure to the air inside, ordinarily, the outer panel takes the cabin pressure.

A single outer panel or a single inner panel is strong enough to withstand the cabin pressure.

The window is fixed to the fuselage structure with screws. Rubber bushings are provided in the screw holes to take the relative motion of the airframe and the window and to serve as sealing.



Sliding Windshield

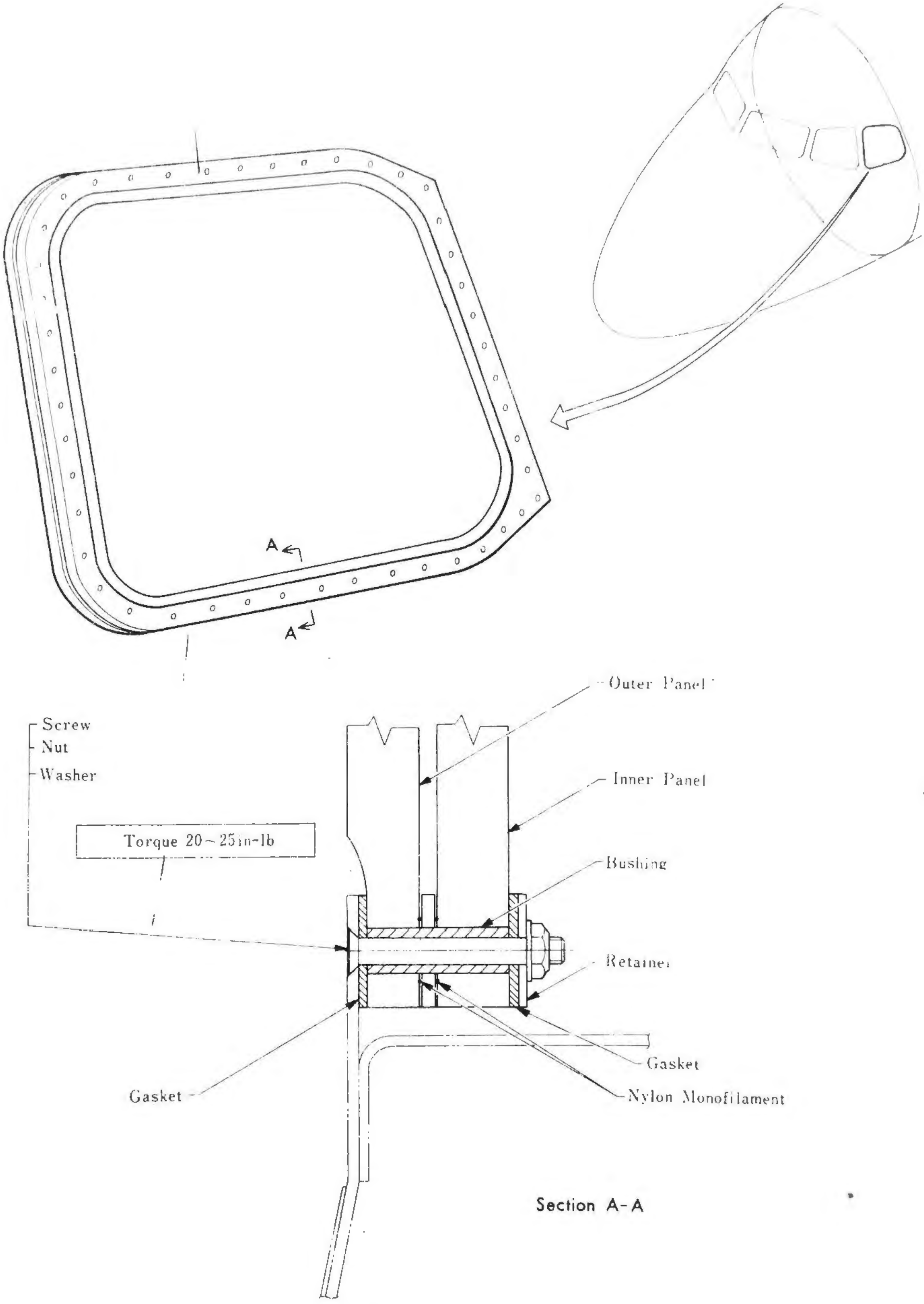
Figure 2-34

2.7.3 Door Windows

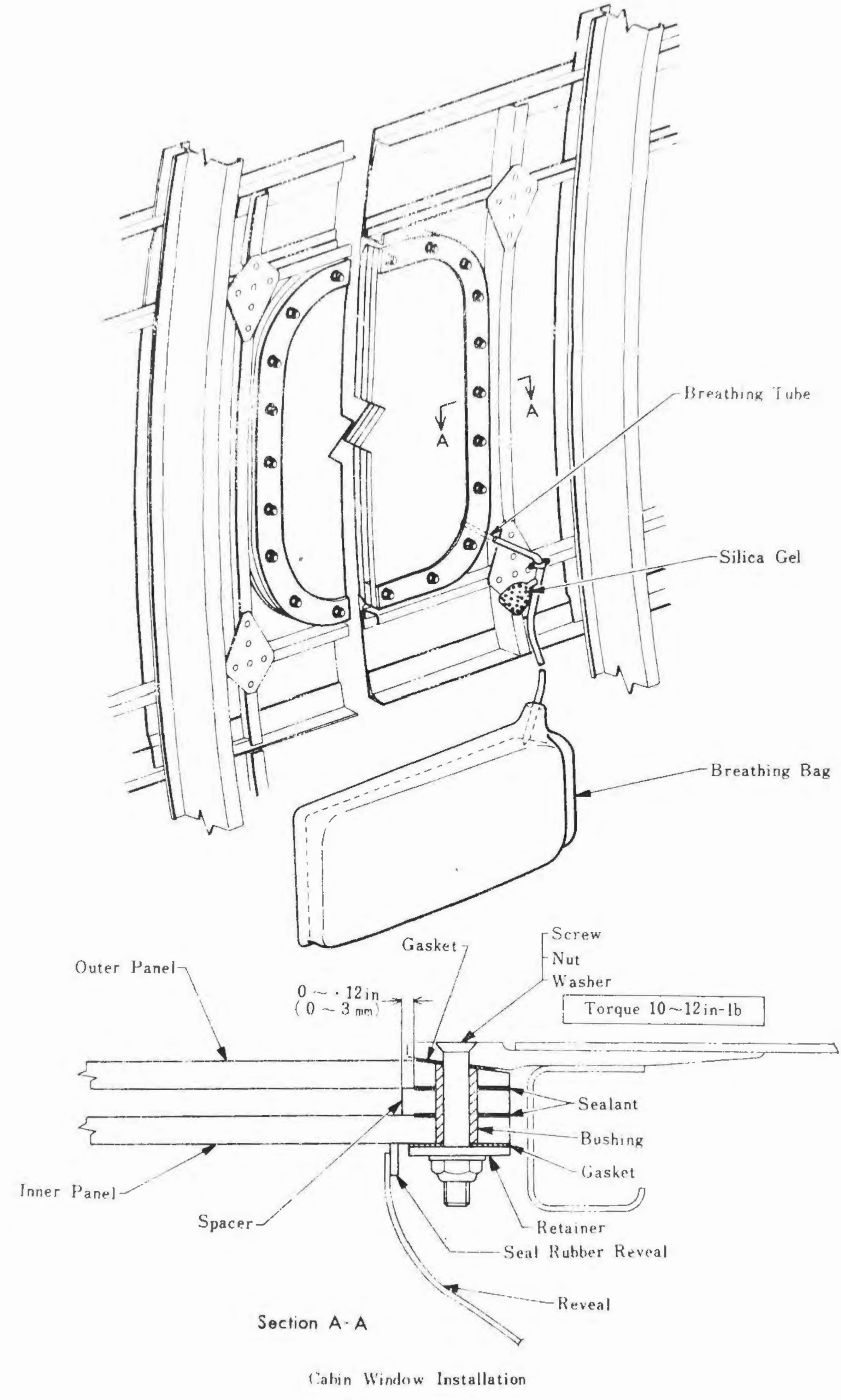
Each of the service door and the aft cargo door has a round window, 140 mm in diameter, on the upper part.

Those windows have double structure of acryl plastic material 3 mm thick. They are fixed to the doors with screws.

No desiccator is provided in these windows.



Side Windshield Installation
Figure 2-35



Cabin Window Installation

Figure 2-36

Chapter 3 LANDING GEAR

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Chapter 3 LANDING GEAR

3.1 General

The landing gear is of nose gear type and is operated by the landing gear control lever mounted on the center pedestal.

Extension and retraction of the gears are accomplished by the hydraulic actuating cylinders and the landing gear doors are opened and closed by door actuating mechanisms.

The landing gear is locked mechanically in their UP or DOWN position. Up-lock is normally released by hydraulic pressure, however, in case of failure of the hydraulic system, an emergency gear down system allows free fall of the gears.

Locking position of the gears is indicated by electrical indication system on the instrument panel in the cockpit. Furthermore, visual indicators are provided for visual check.

The main landing gear is of dual wheel type with the brake assembly and the nose landing gear is of co-rotating dual wheel type with the steering system.

Both normal and emergency brake systems are operated by hydraulic pressure, and an electrical anti-skid mechanism is provided in the normal brake system.

3.2 Main Landing Gear

3.2.1 Shock Strut

Left and right shock struts which look like the letter Y are interchangeable between them. The shock strut is mounted on the shock strut mounting fitting on the bottom surface of the wing with pins which are held in place by tie rods.

The shock strut consists of a cylinder and a piston, both connected each other with the torque arms.

Inside the cylinder a plunger tube is suspended from top and an orifice plate is provided at the end of the plunger tube. There are a metering pin and a recoil valve in the piston.

Impact load to the aircraft is controlled and absorbed by the orifice plate and the metering pin. The shock strut is so designed that it can be easily compressed and hardly extended due to the function of the recoil valve.

Filling ports for oil and air are located on the top of the strut. Oil MIL-H-5606A shall be used.
The gap between the cylinder and the piston is sealed with the "O" ring and back up ring packing.

Remove the gland nut at the lower part of the shock strut, and two spare "O" rings come out.

Therefore, replacement of "O" ring with spare one without pulling out the piston is permitted once only.

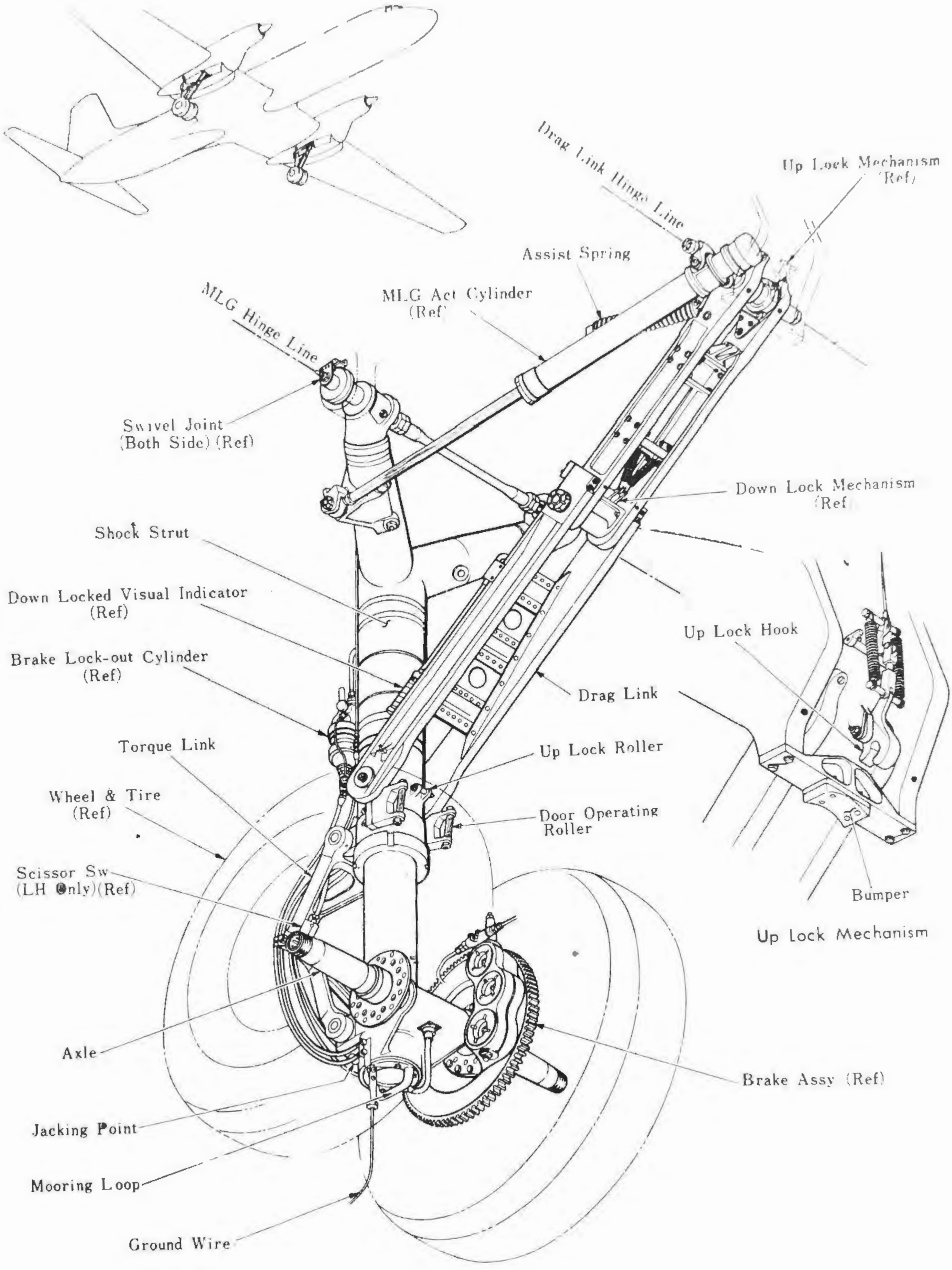
3.2.2 Drag Link

The drag link consisting of the upper and lower drag links is attached to the middle part of the shock strut and the lower part of the front spar of the main wing.

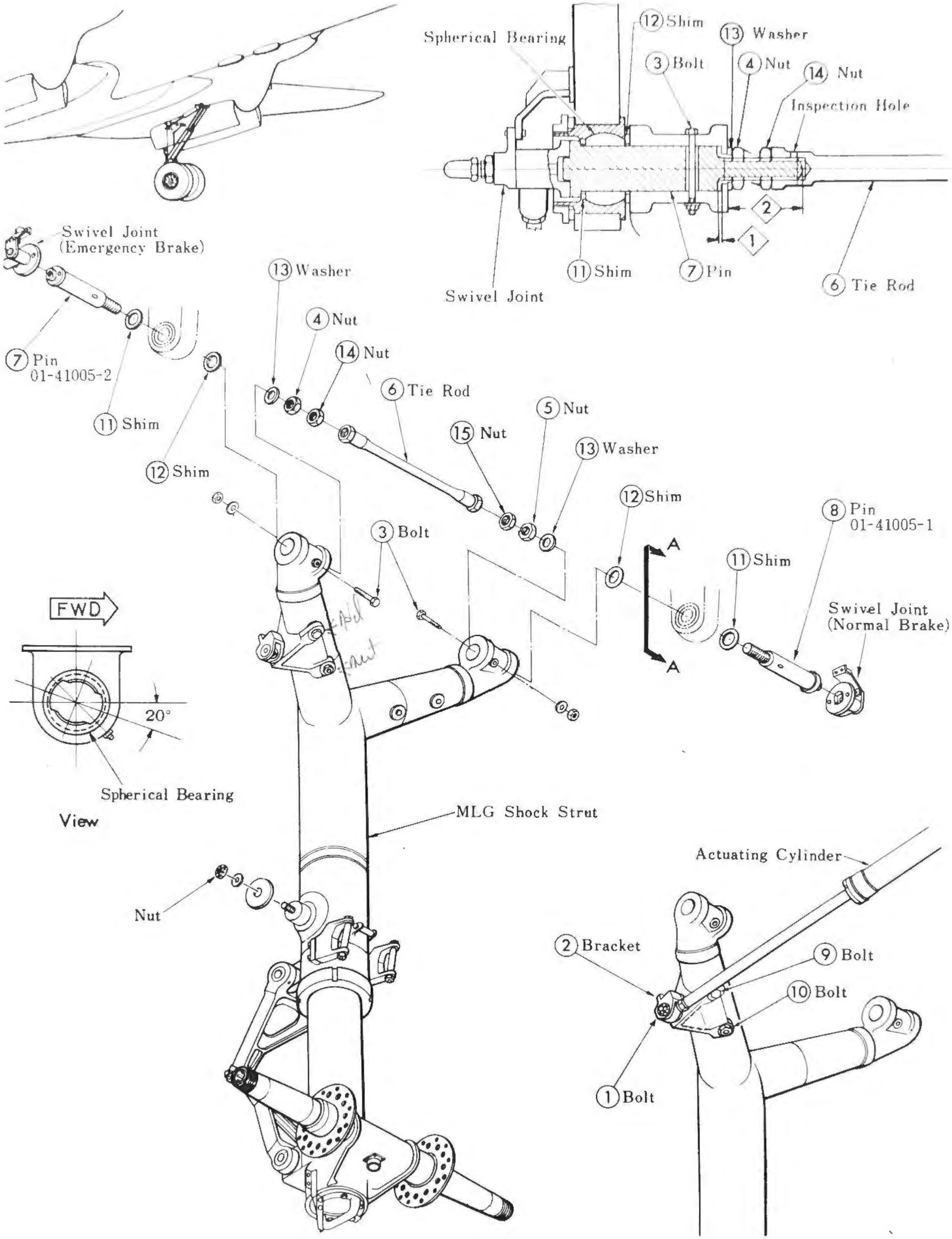
When the landing gear is extended, both links are in a straight line, on the other hand, when retracted they are folded rearwards at the joint.

At the joint section, is located a down-lock mechanism which locks the strut when the gear is extended.

To the shaft of the upper mounting section of the upper drag link, a gear actuating cylinder and an assist spring are mounted. Down-lock indication system is installed on the lower drag link.

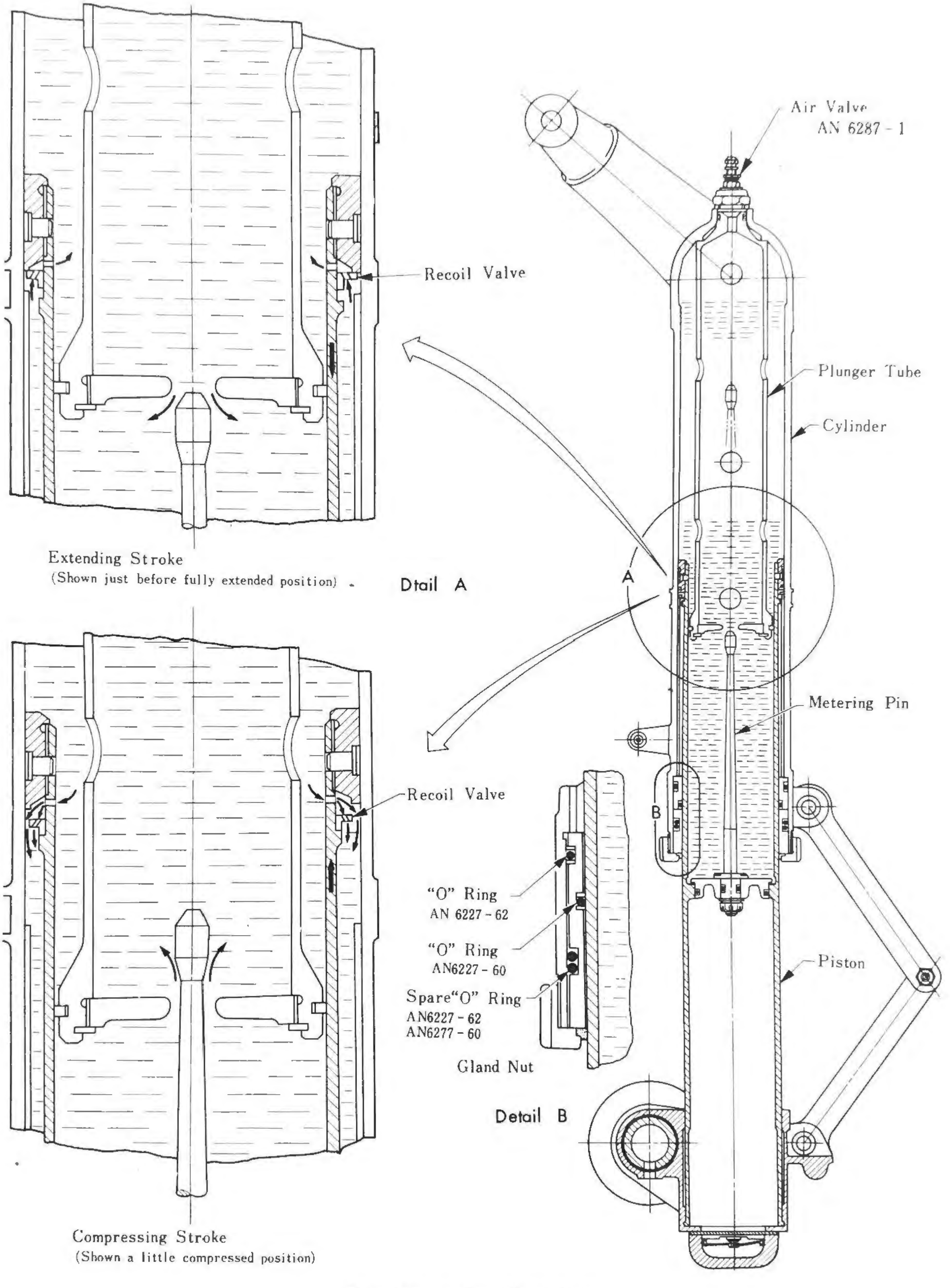


Main Landing Gear
Figure 3–1

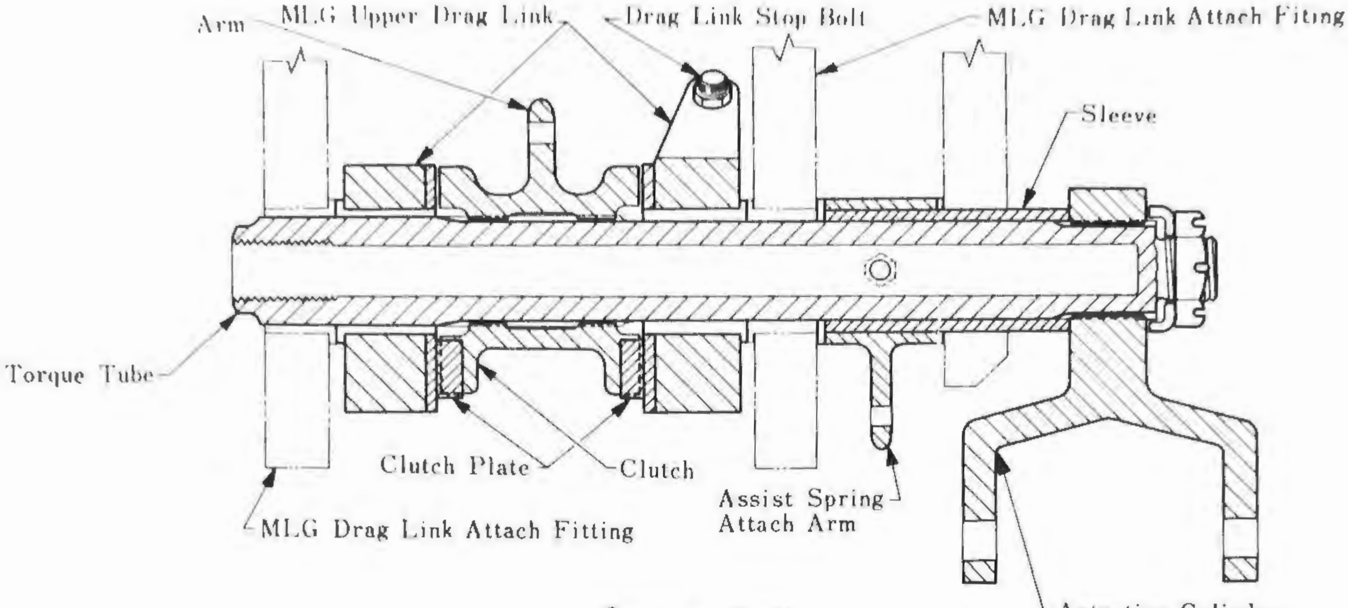


Main Landing Gear Shock Strut Remove/Install

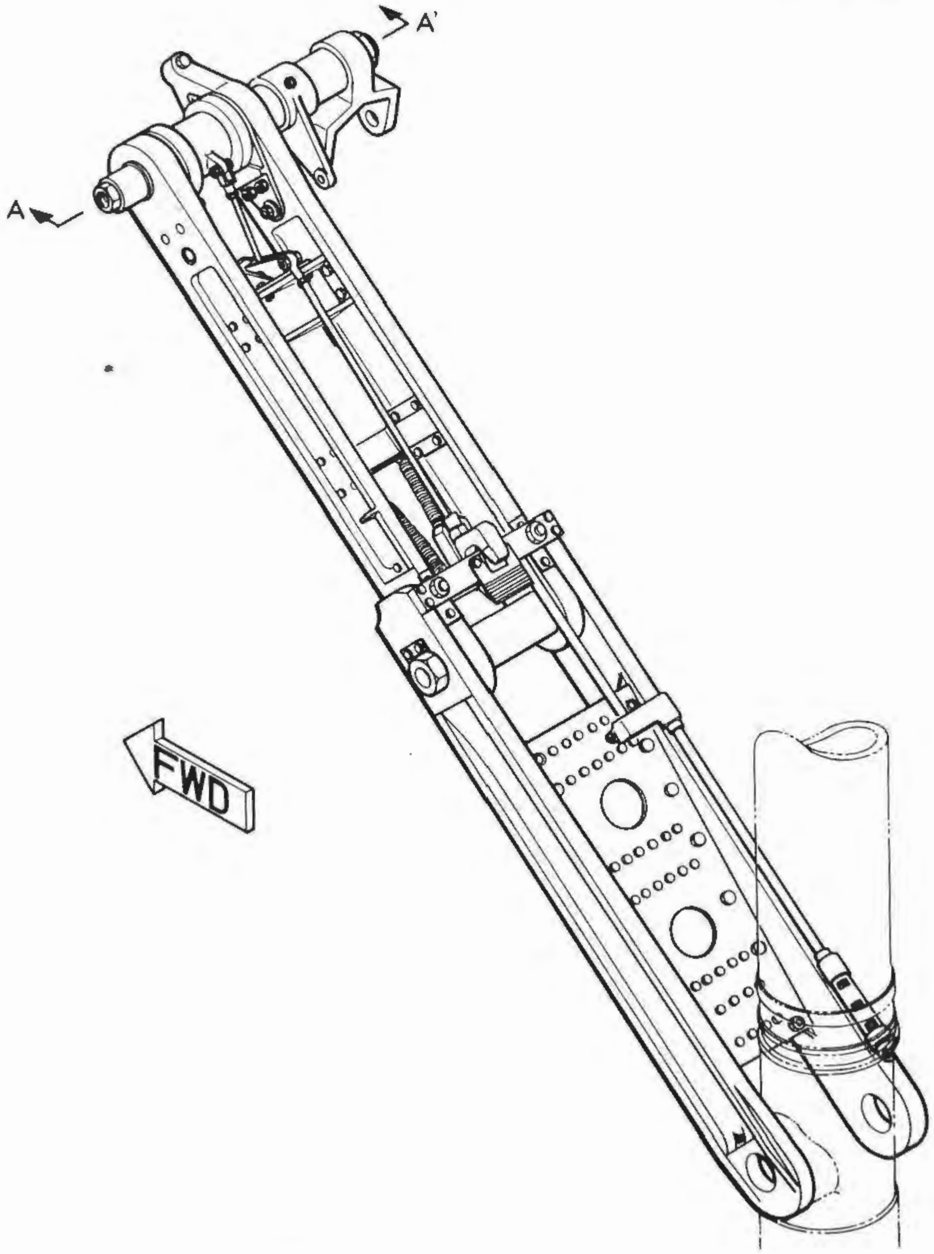
Figure 3–2



Main Landing Gear Shock Strut
Figure 3–3



Section A-A'



Main Landing Gear Drag Link

Figure 3–4

3.3 Nose Landing Gear

3.3.1 Shock Strut

To the T-shaped shock strut, the left and right side-struts are attached. Both ends of T-shaped strut are attached to the FUS STA-1[illegible] fittings which can be separated into upper and lower parts.

Main difference from the main landing gear is a built-in centering cam which makes the wheel face front properly when the piston of the shock strut is fully extended.

The filling ports for air and oil are located on the top of the shock strut. Oil, MIL-H-5606A shall be used.

The spare "O" rings are also contained inside like the main gear.

3.3.2 Drag Link

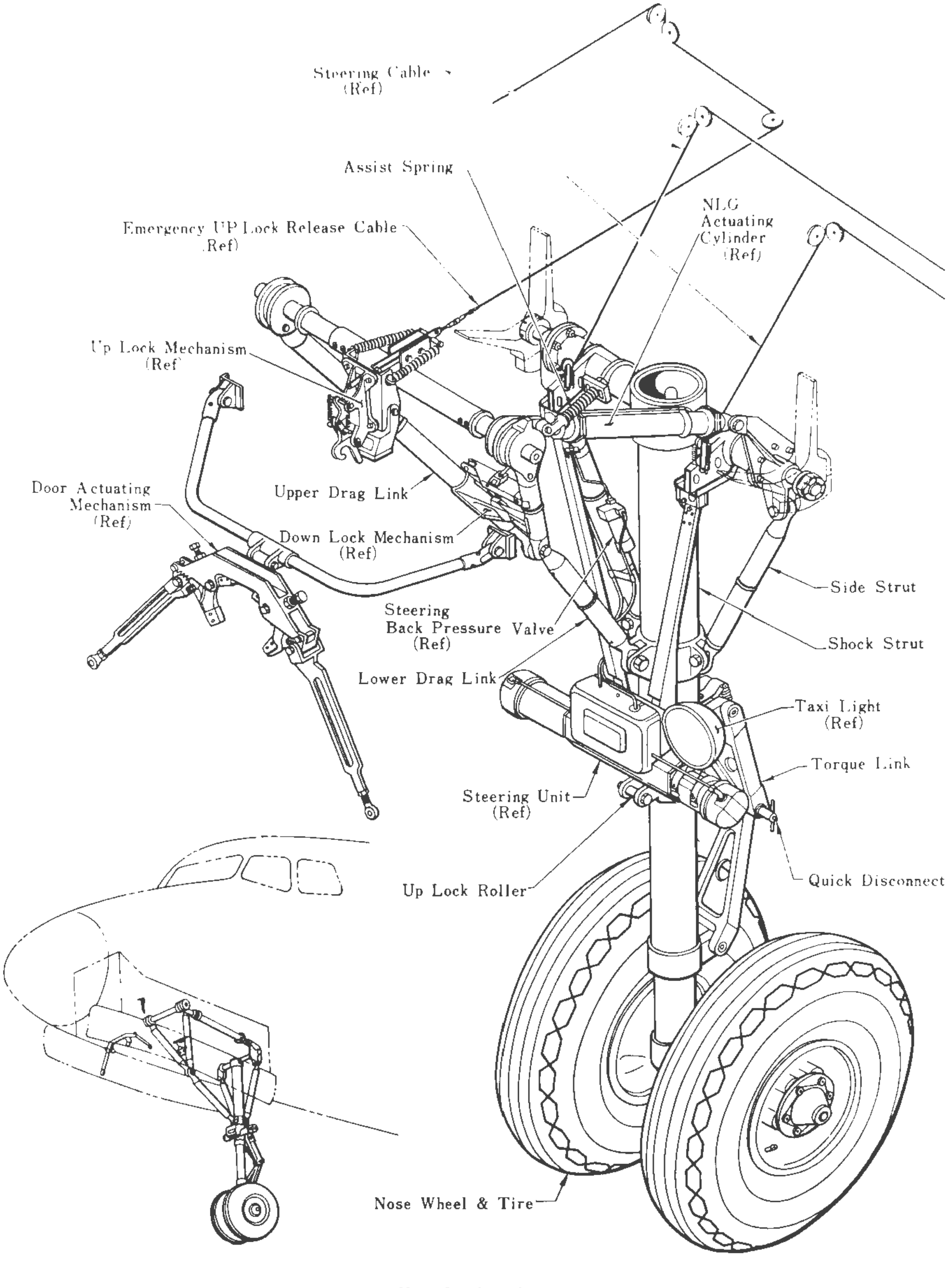
The drag link is composed of one lower drag link and two upper drag links.

The upper drag links are mounted on the fuselage at the forward portion of the landing gear well with pins and shaft; the lower drag link is fixed to the shock strut with standard bolts.

When the gear is extended, both links become a straight line and when retracted they are folded rearwards at the joint.

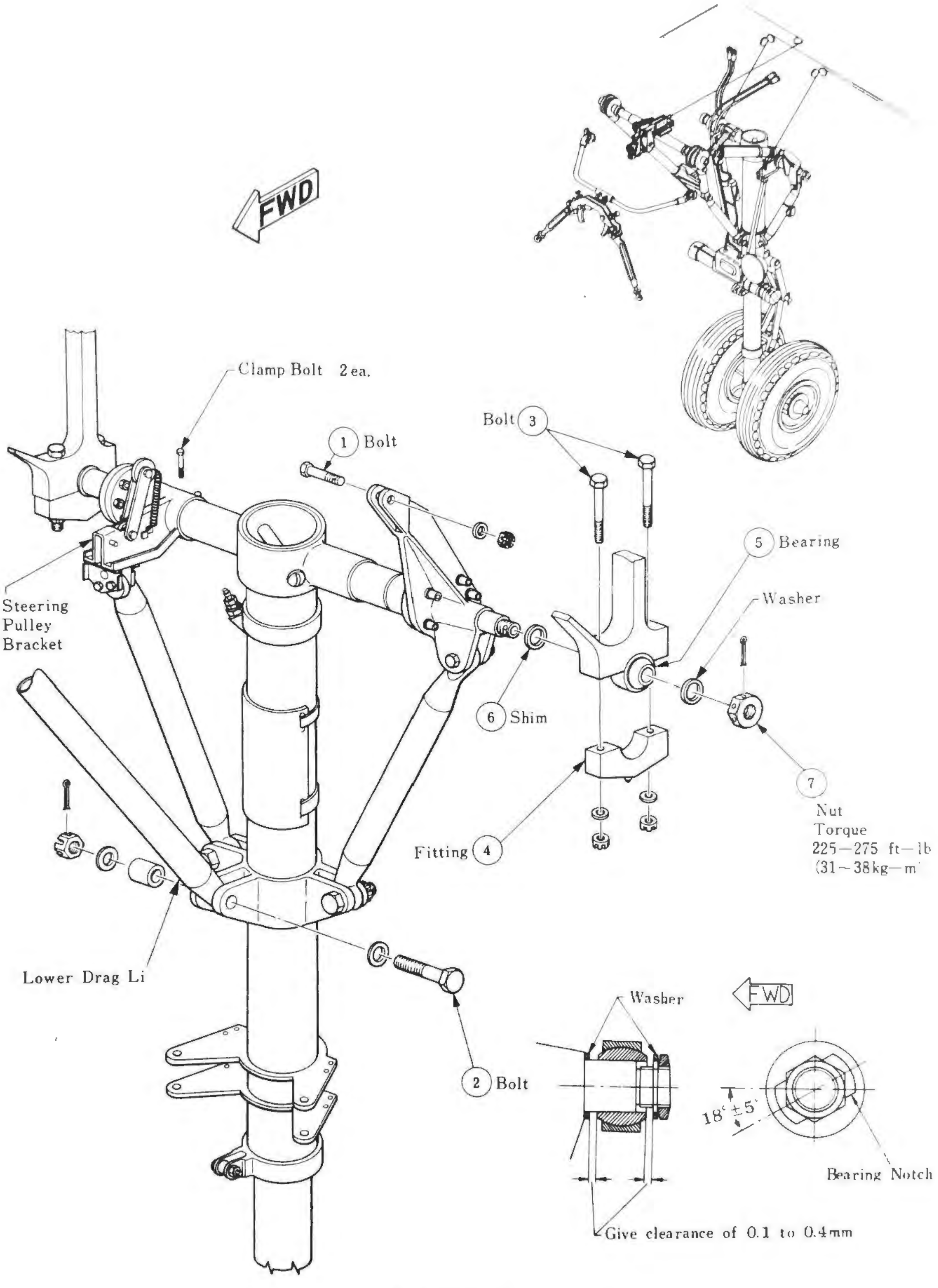
On the joint, there is a down-lock mechanism to lock the strut when the gear is extended.

On the pin of the upper mounting section of the upper drag link, a actuating cylinder and an assist spring are mounted.



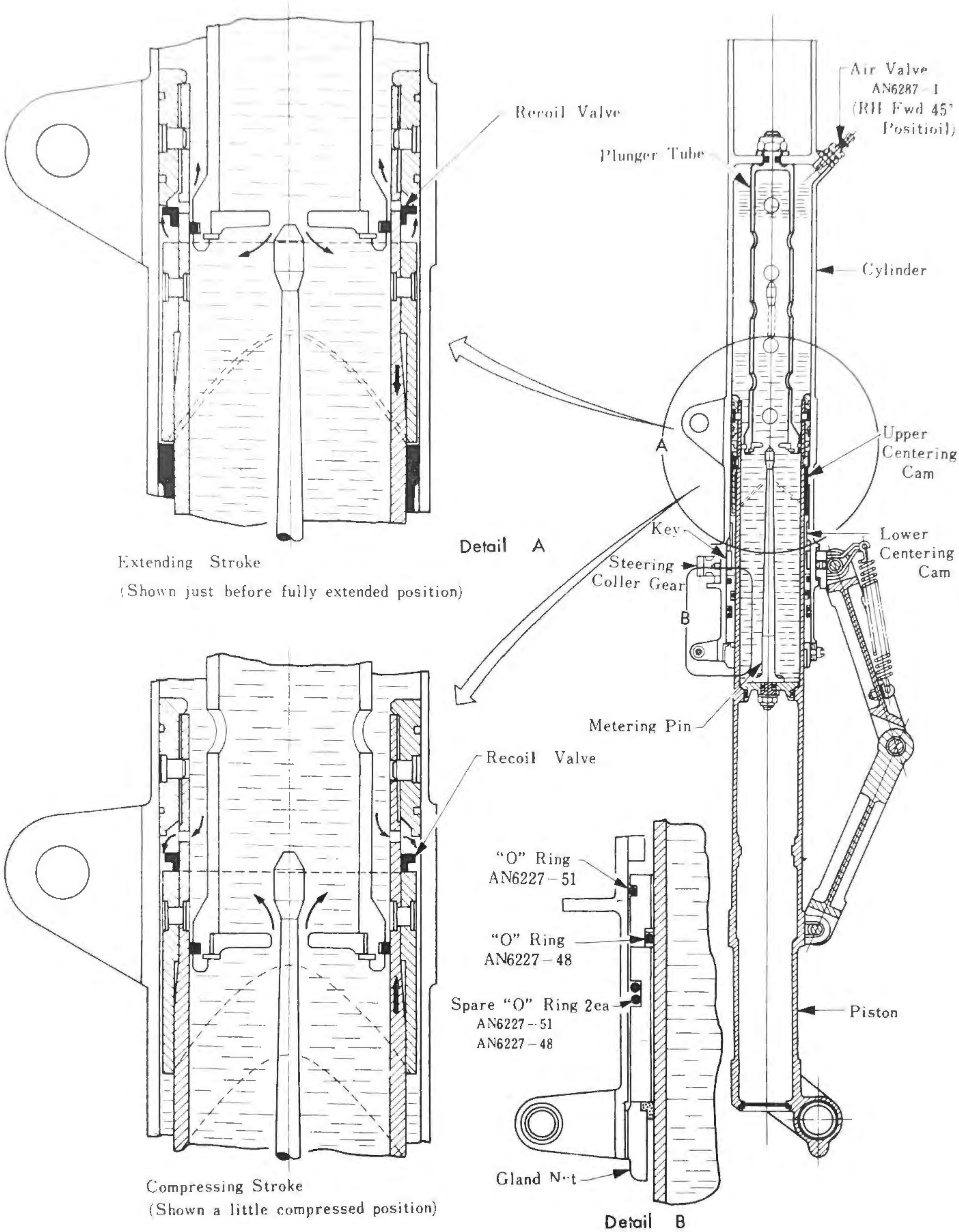
Nose Landing Gear

Figure 3-5

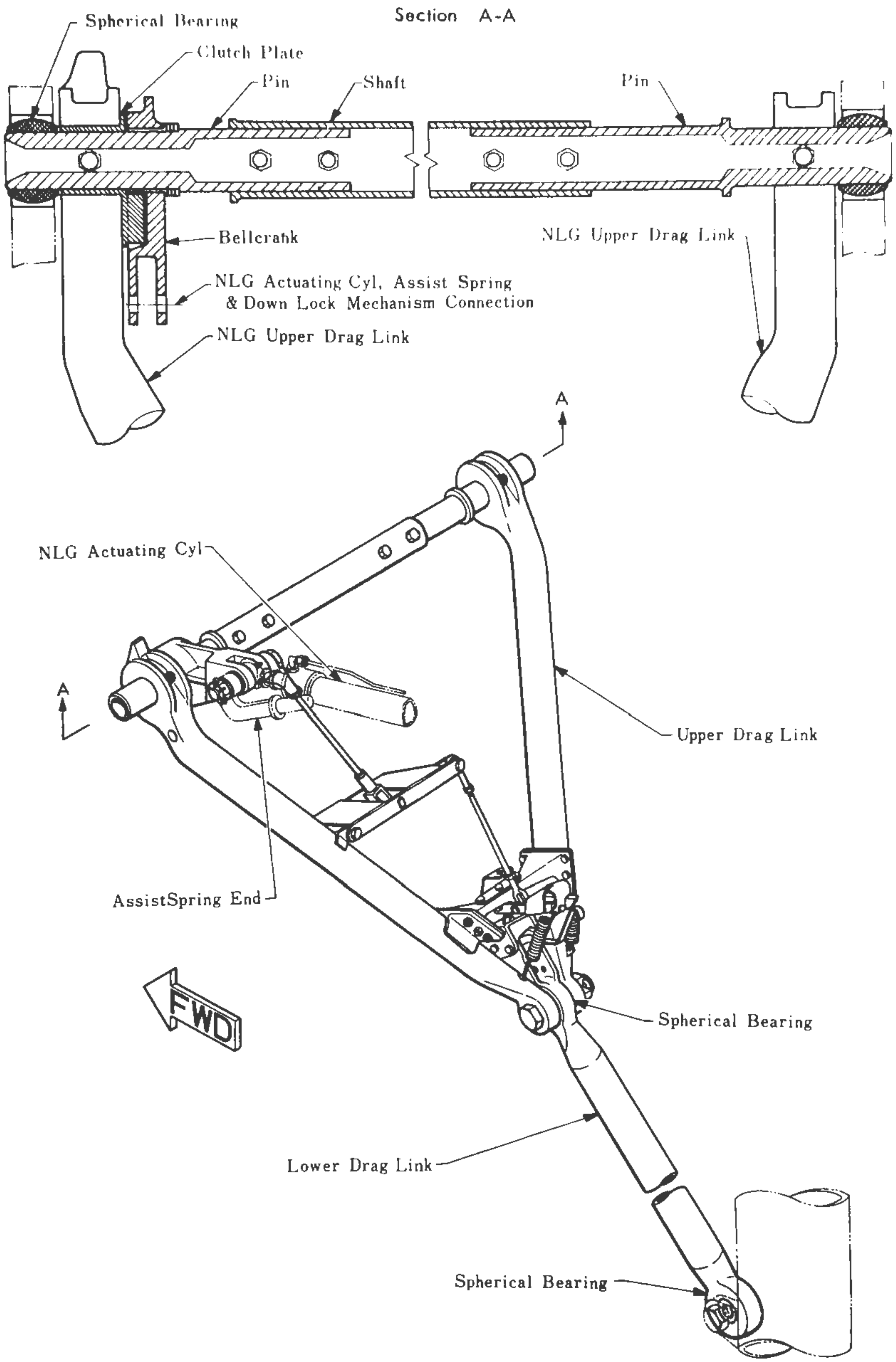


Nose Gear Shock Strut Remove/Install

Figure 3–6

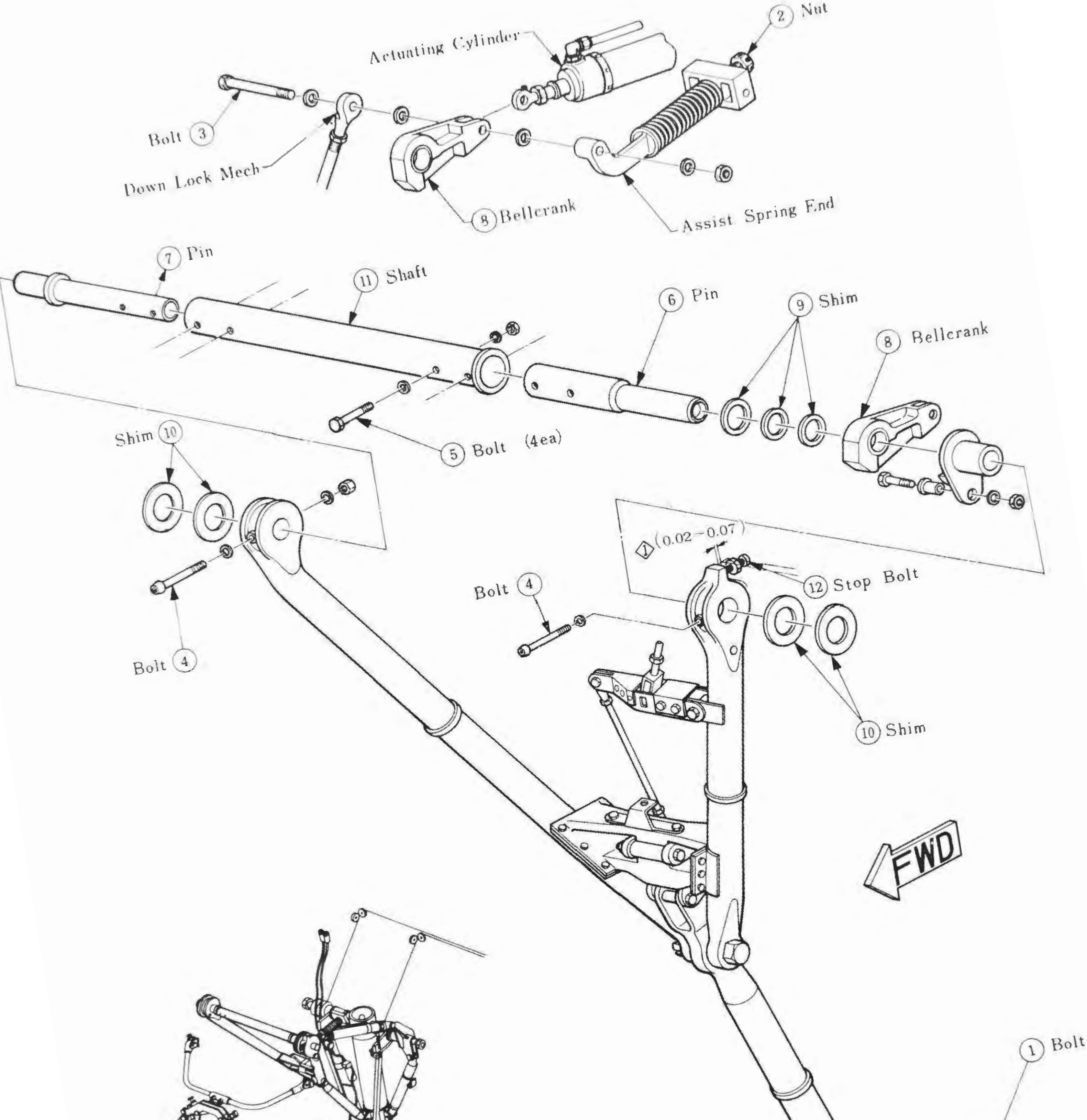


Nose Landing Gear Shock Strut
Figure 3-7



Nose Landing Gear Drag Link

Figure 3-8



Nose Gear Drag Link Remove / Installation
Figure 3–9

3.4 Extension and Retraction System

3.4.1 Construction

The extension and retraction system consists of the following sub-systems:

(1) Landing Gear Selector Valve Control System

(2) Landing Gear Actuating Hydraulic System

(3) Down-Lock Mechanism

(4) Up-Lock Mechanism

(5) Main Gear Door Actuating Mechanism

(6) Nose Gear Door Actuating Mechanism

(7) Emergency Up-Lock Release System

3.4.2 Operation

(1) Retraction

A. When the landing gear lever is set to "UP" position, the cable connected to the lever operates the selector valve in hydraulic compartment, supplying pressure oil to each actuating cylinder and up-lock release cylinder.

B. The actuating cylinder releases the down lock, folds the drag link rearwards and retracts the gear.

C. When the gear is retracted, the door link is caught by the shock strut pulling up the door to close it.

D. Once the gear is retracted, the up-lock hook holds the up-lock roller attached to the shock strut and automatically the gear is locked in the up-lock position.

(2) Extension

A. When the landing gear is set to "DOWN" position, pressure oil is supplied to each actuating cylinder and up-lock release cylinder.

B. The up-lock release cylinder extends, releasing the up-lock.

C. The actuating cylinder extends the drag link to lower the gear.

D. The shock strut pulls the door downward to open it.

E. The gear is locked in the down-lock position.

(3) Emergency Gear Down

In case of hydraulic system failure, pull the emergency up-lock release handle installed on the front part of the right side-panel, and the up-locks of all the gears will be released permitting free falls.

3.4.3 Operation Test

Jack up the aircraft, and connect the external power source and hydraulic test stand to the aircraft.

(1) Make certain the function of the indicating lights during retraction and extension, and also when the gear is locked in down-lock and up-lock position.

(2) Check the gear for its retracting operation, and the door for its closing operation.

(3) Set the gear lever to "NEUTRAL" with the gear up-locked. Make certain that, when the engine throttle lever on one side is pulled back, the buzzer sounds and the light on the gear lever comes on. (When throttle lever is pulled back, the micro switch is energized.)

(4) Lower the wing flap to 22.5 degrees or more, and make certain that the buzzer sounds and the light on the gear lever comes on.

(5) Pull the emergency up-lock release handle, and make sure that the three gears can perform free fall.

(6) Set the gear lever to the "DOWN" position.

(7) Set the landing gear down-lock check switch to the "ON" position, and check the visual indicator.

(8) Ascertain that, when the circuit breaker of the scissor relay is drawn, the landing gear lever is not moved to the "UP" position.

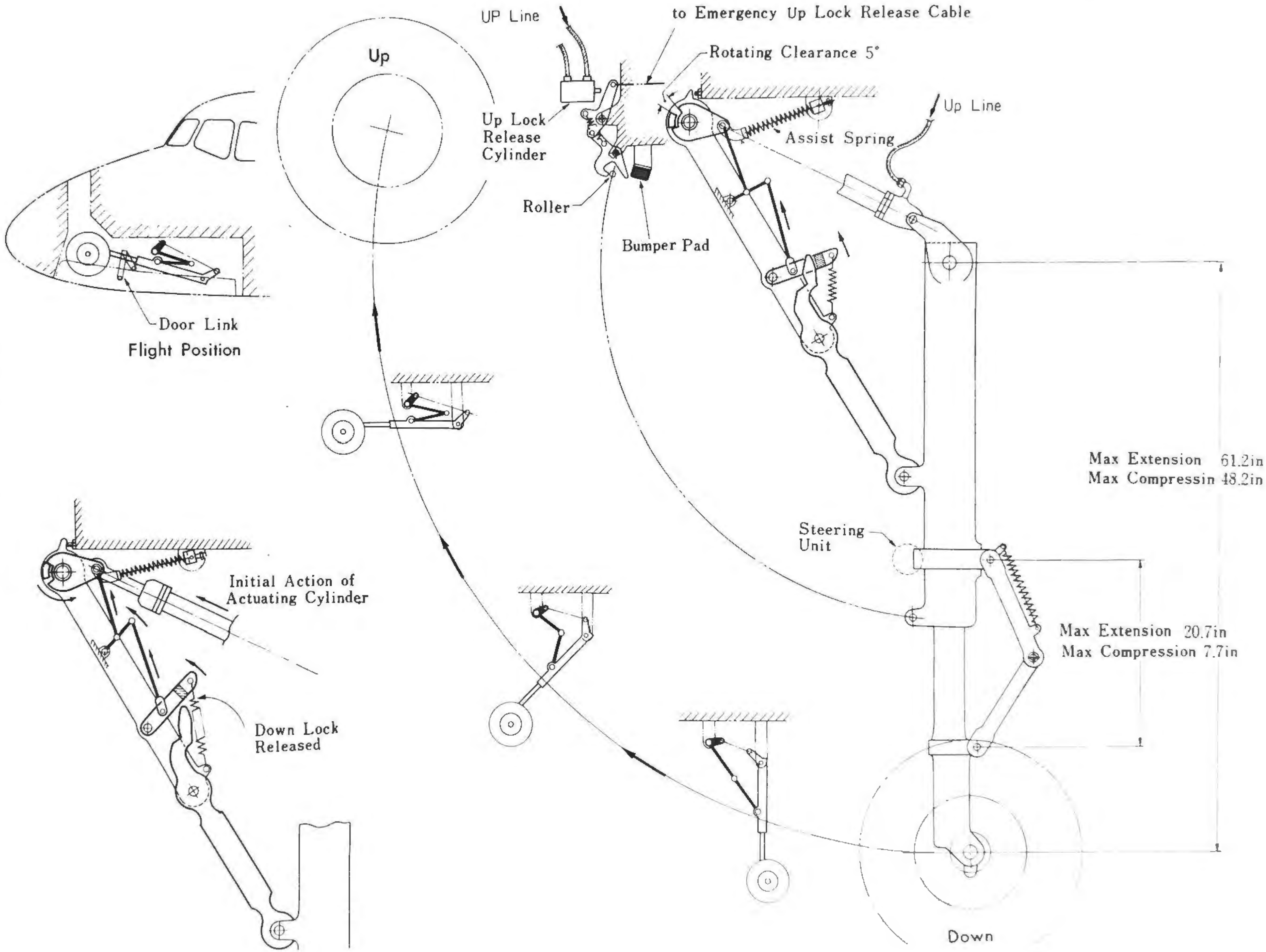
(9) With the override switch in "OVERRIDE", the gear is retracted.

(10) With the landing gear control lever set to the "UP" position, pull the emergency up-lock release handle, and make certain that, when the emergency landing gear release valve handle is pulled, the gear is allowed to make a free fall.

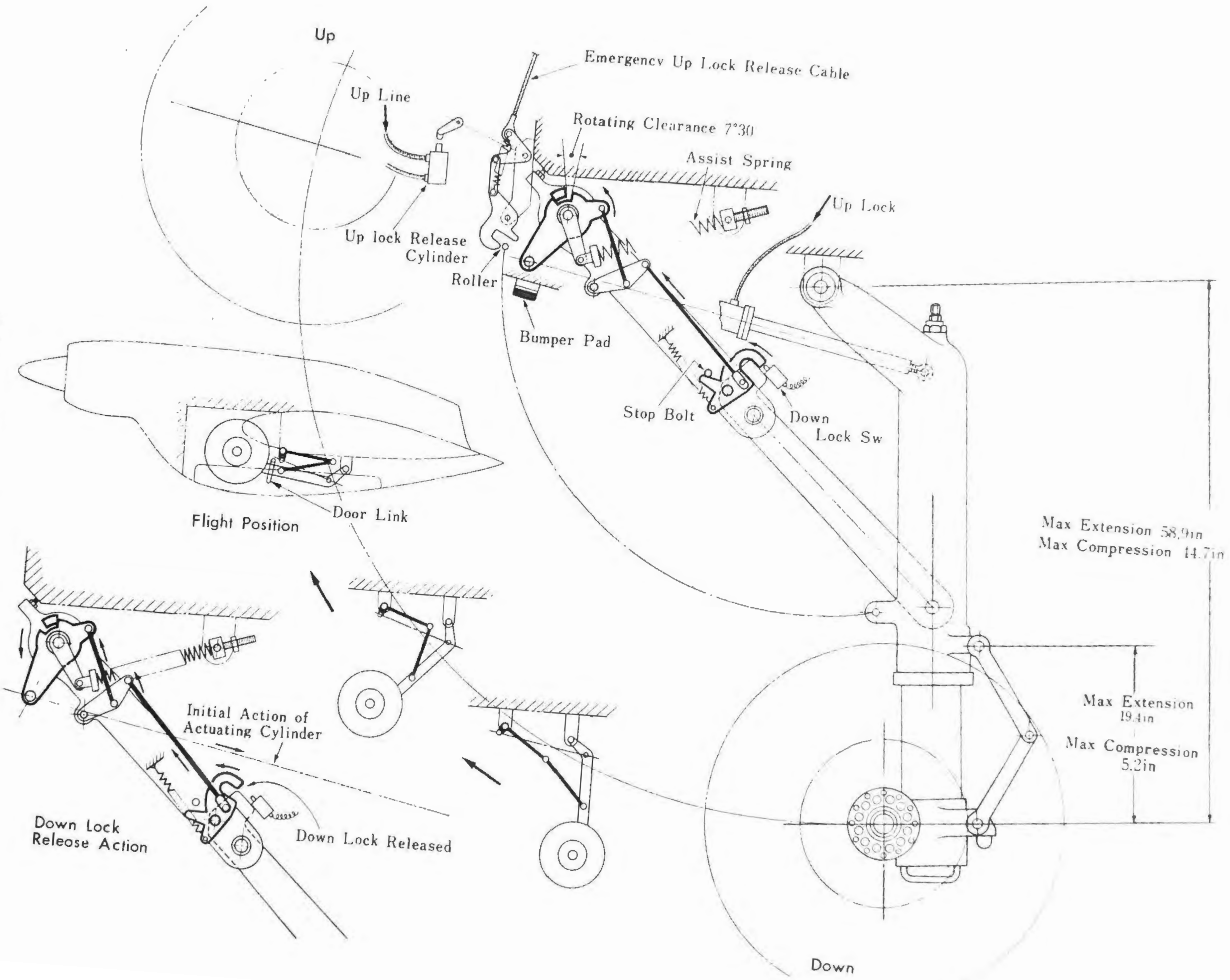
3.4.4 Landing Gear Selector Valve Control System

(1) General

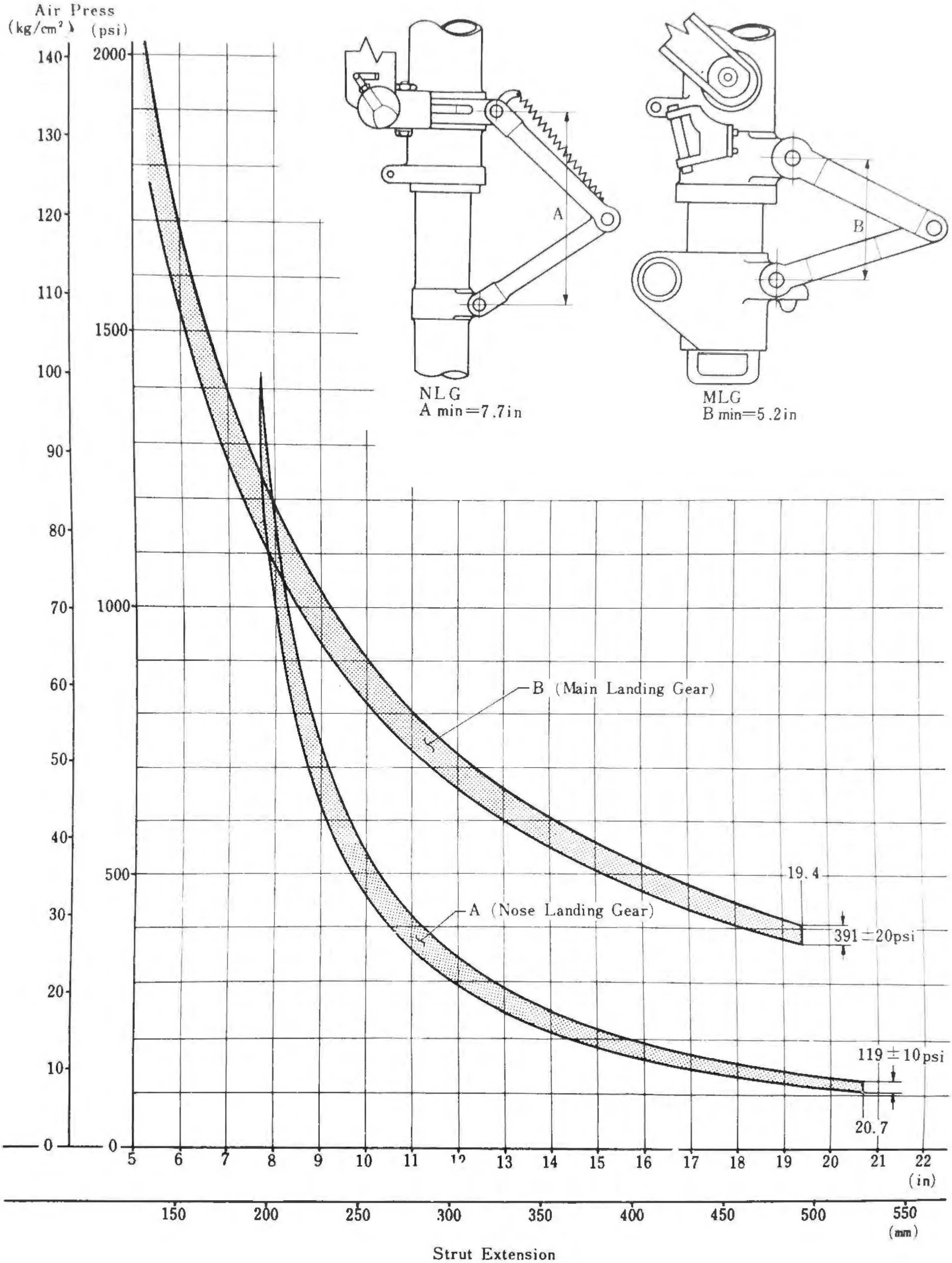
The landing gear control lever is located on the right-hand side of the engine instrument panel, and the motion of the lever is transmitted through the rod and cable to the landing gear selector valve in the hydraulic compartment.



Nose Gear Extension & Retraction
Figure 3-10



Main Gear Extension & Retraction
Figure 3–11



Landing Gear Shock Struct Air Servicing

Figure 3-11A

Reserved

When the aircraft is on the ground a solenoid pin prevents the lever from moving to the "UP" position.
The solenoid pin is released when the aircraft becomes airborne (scissor relay is in "FLT"), then the lever can be moved to "UP". However, even the scissor relay has been set to "GROUND", the lever can be moved to "UP" if the override switch is turned to "ON".

WARNING: Do not turn the override switch to "ON" when the aircraft is on the ground.

(2) Adjustment

A. Install the rig pins (1), (2) and adjust the length of the rod (3).

B. Install the rig pin (5) and adjust cable tension.

The value of tension is 28.5 ± 4.4 lb at 20°C. (Cable tension varies by ±0.7 lb per 1°C.)

C. Set the selector lever to "NEUTRAL", and adjust the rod (7).

D. Move the gear lever up and down until the selector lever is switched to "UP" or "DOWN", and fix the adjust plate.

3.4.5 Landing Gear Actuating Hydraulic System

(1) Composition

This system is composed of the elements described below and hydraulic piping. The selector valve is located in the hydraulic compartment, and other elements are fixed on and around the landing gears.

A. Landing Gear Selector Valve

B. Main Gear Actuating Cylinder

C. Nose Gear Actuating Cylinder

D. Main Gear Up-lock Cylinder

E. Nose Gear Up-lock Cylinder

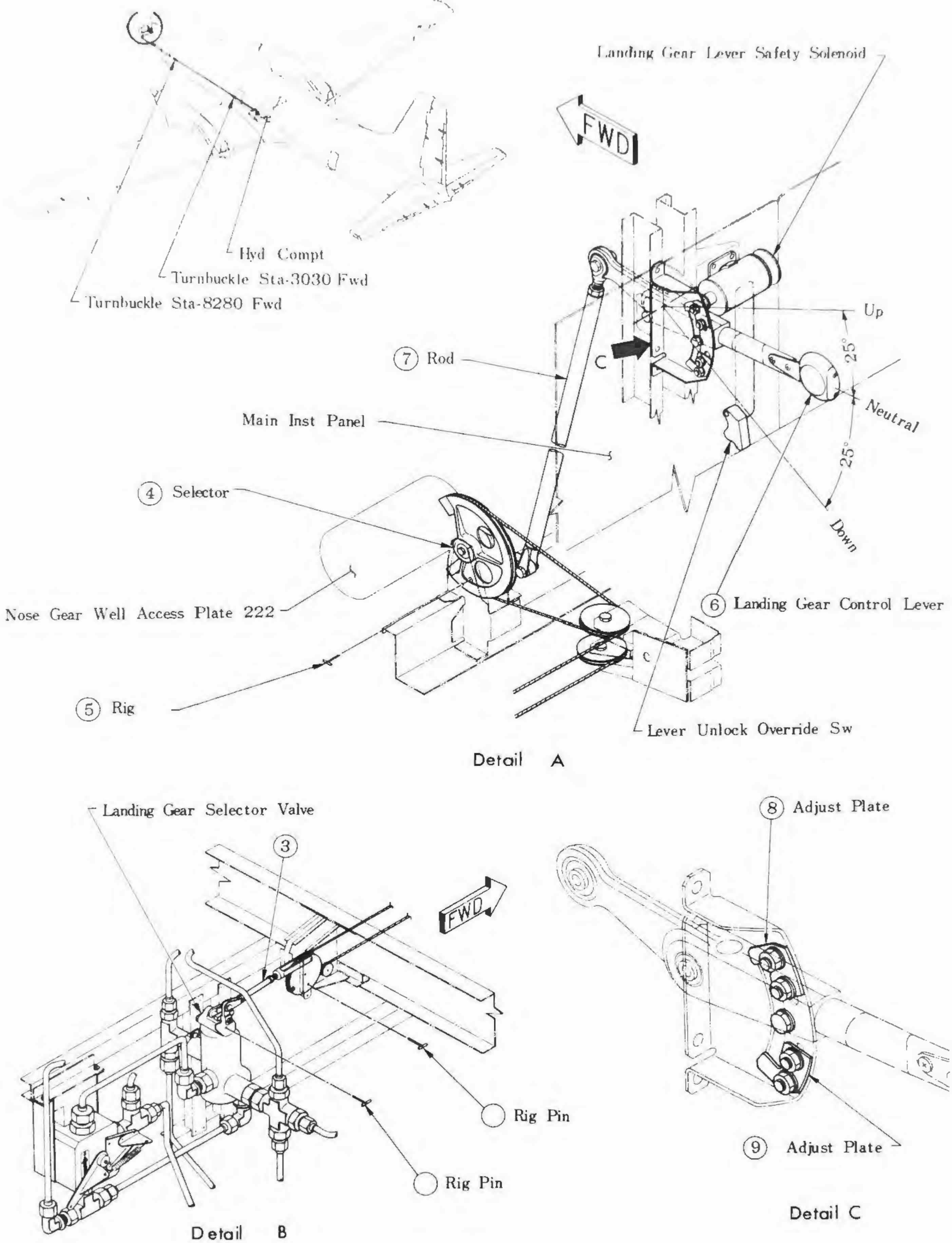
F. Main Gear By-pass Valve

G. Pressure Reducing Valve

(2) Operation

A. Gear Retraction

(A) With the landing gear control lever is "UP", the selector valve permits hydraulic pressure to enter the gear up line.



Rigging-Landing Gear Selector Valve Control System
Figure 3–12

(B) The hydraulic pressure to the nose gear is reduced to 2000 psi through the pressure reducing valve.

(C) The up-lock release cylinder rod of the gears are retracted so that the gears can be locked mechanically by the up-lock hook.
The up-lock release cylinder is of simple reciprocating piston type.

(D) Pressure oil in the nose gear actuating cylinder extends the actuating cylinder. (releases the down-lock and retracts the gear)
The nose gear actuating cylinder is provided with dash pots at both ends which reduce impact load at the final stage of retraction; the stroke is 14.0 in.

(E) Hydraulic pressure in the "C" port under the by-pass valve of the main landing gear pushes upward the cone in the valve, reaching the "B" port, retracting the main gear actuating cylinder.
The main gear actuating cylinder is provided with dash pots at both ends; the stroke is 21.8 in.

(F) Hydraulic oil in the DOWN side of each actuating cylinder returns to the reservoir.

B. Gear Extension

(A) Set the landing gear control lever to "DOWN", and pressure oil from DOWN port of the selector valve flows into the DOWN line.

(B) All the up-lock release cylinders are extended, releasing them.

(C) The nose actuating cylinder is retracted (lowering the gear).

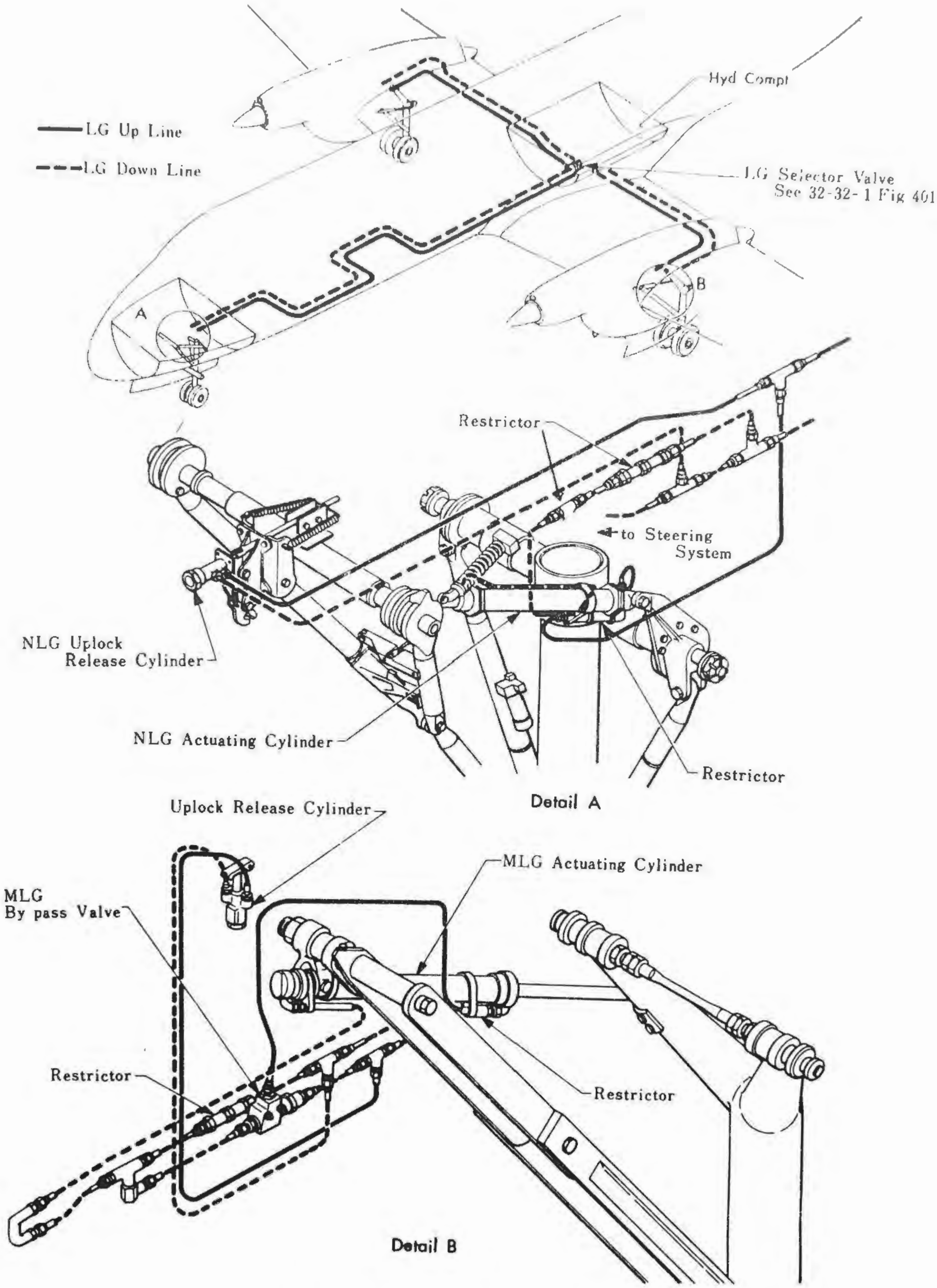
(D) In the case of main gear actuating cylinder, pressure oil enters both DOWN side and UP side, however, the piston can be extended to lower the gear due to the difference in area exposed to the oil pressure.

(E) Oil in the nose gear actuating cylinder returns to the reservoir through the UP line.

C. Emergency Landing Gear Extension (Free Fall)

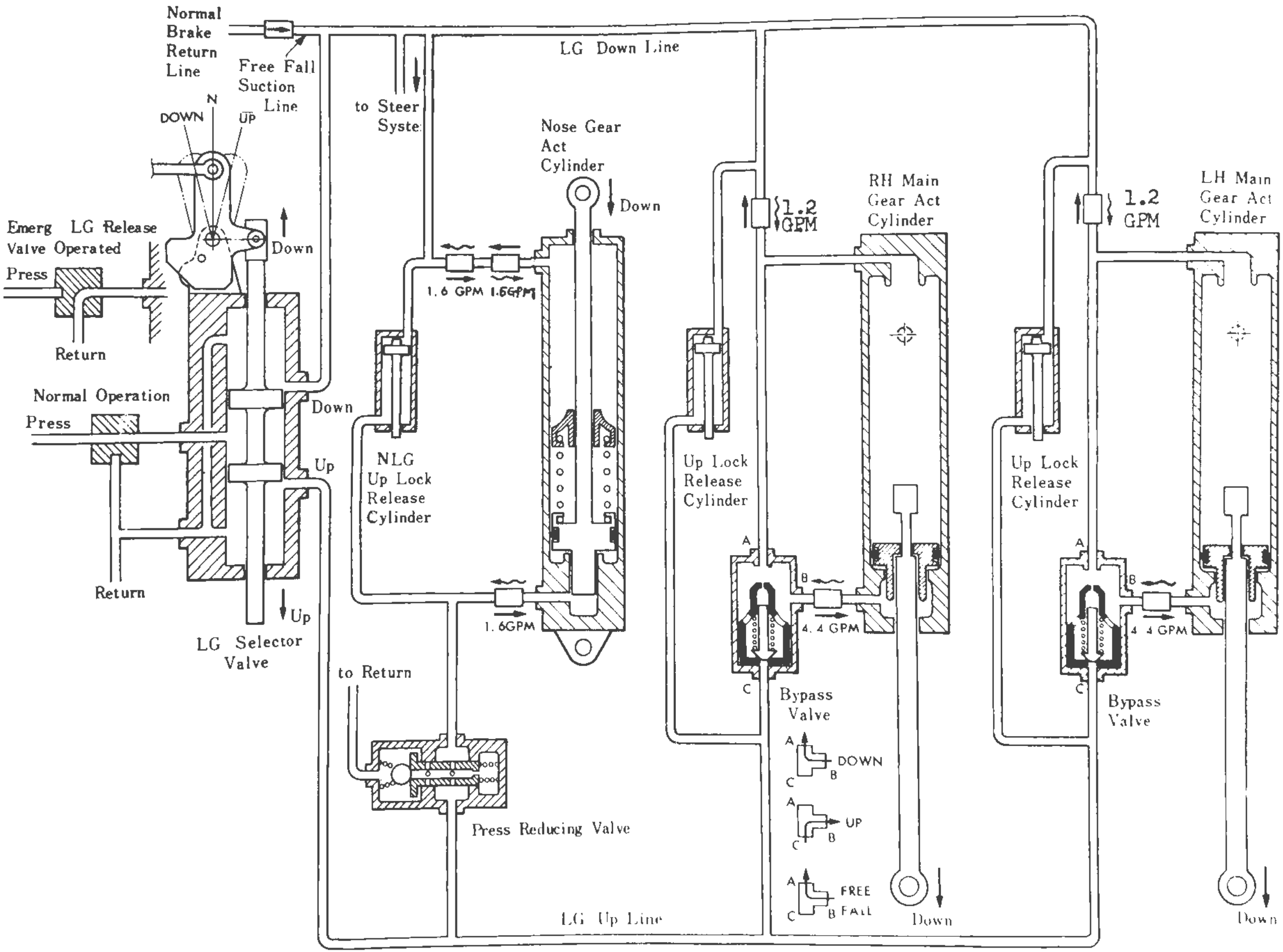
The landing gear can perform a free fall in the case of hydraulic system failure.

(A) Pull the emergency up-lock release handle, and all the up-locks of the gears are released through cables.



Landing Gear Actuating Hyaraurıc System

Figure 3–13



Landing Gear Actuating Hydraulic System
Figure 3-14

(B) The gears are lowered freely with their own weights.

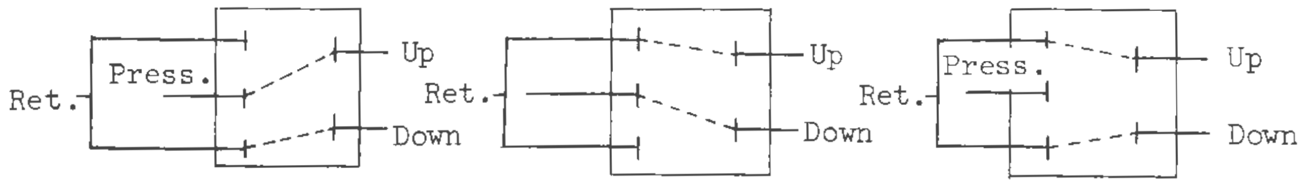
(C) Hydraulic oil in the nose gear returns to the reservoir through the UP line, while in the main gear, oil flows into the DOWN line through the by-pass valve.

(D) To fill up the shortage of oil in the DOWN line, oil or air is supplied from the brake return line.

(E) When the landing gear control lever is stuck at the UP position (the cable is cut), pull the knob of the emergency gear extension valve after pulling the emergency up-lock release handle, and the gear falls freely.

(3) Selector Valve

The selector valve is installed at the front, left corner of the hydraulic compartment. The valve is operated by a cable connected to the landing gear control lever. According to the lever positions, the following circuits are made:



Up Down Neutral

(4) By-Pass Valve

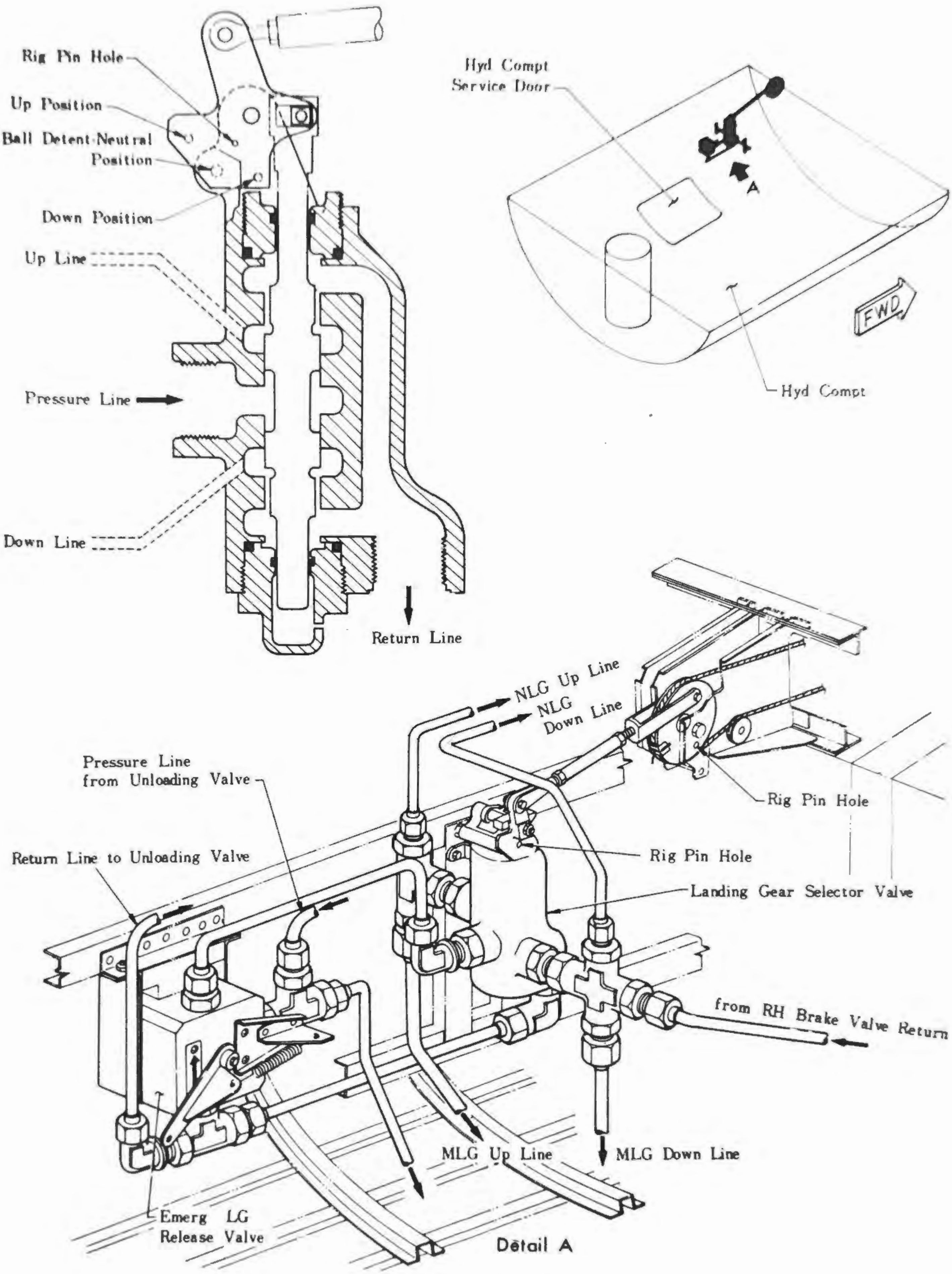
The by-pass valve is used for the following purposes:

A. Decrease the amount of pressure oil to be used for gear extension.

B. Reduce the piston area exposed to oil pressure at the time of gear extension to prevent buckling of the piston rod.

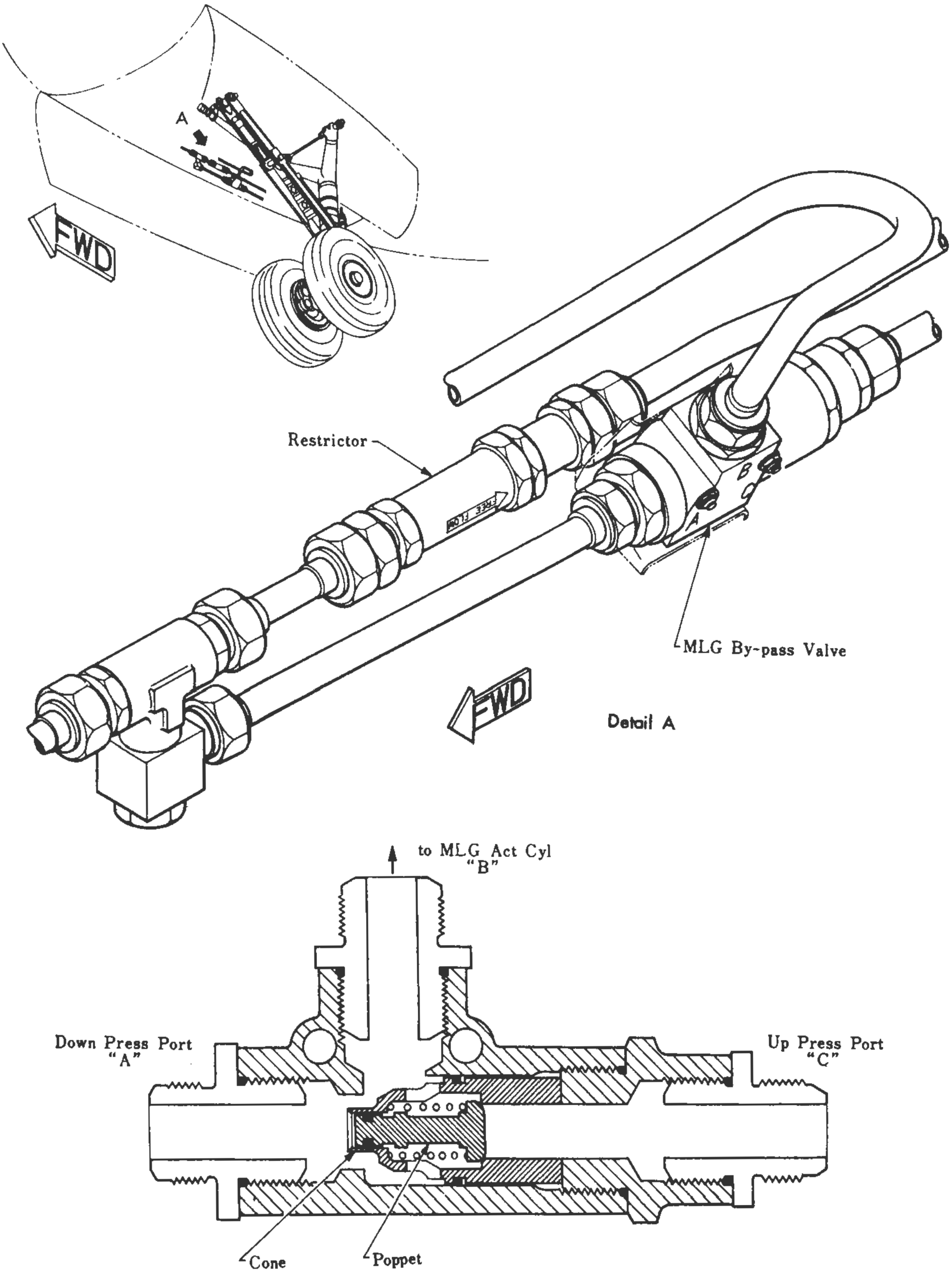
C. Shorten the hydraulic oil line used in case of emergency gear extension.

The by-pass valve is of shuttle valve type with a check valve and it has three ports; A, B and C. Their connection is shown below:



Landing Gear Selector Valve

Figure 3-15

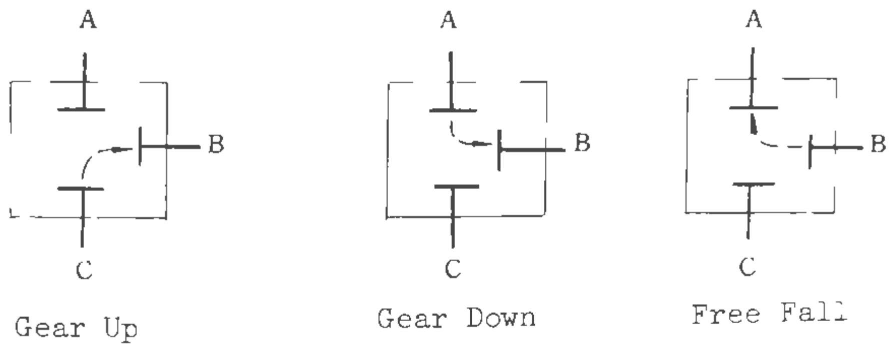


Main Londing Gear By-Pass Valve

Figure 3–16

"A" port	Down pressure line
"B" port	Landing gear actuating cylinder
"C" port	Up pressure line

According to operations, the following circuits are made:



(5) Emergency Landing Gear Release Valve

The handle of the emergency landing gear release valve is located under the detachable floor of the cabin aisle.

When the selector valve is stuck at the UP position, the gear can not be lowered; therefore, this valve, shuts off pressure oil just before the selector valve and simultaneously connects the UP line to the return line.

3.4.6 Down Lock Mechanism

(1) General

Each gear has its own down-lock mechanism by which the gear is locked mechanically in the down-lock position and it is unlocked hydraulically. The down-lock mechanism of the main gear is almost identical to that of the nose gear; when the upper and lower drag links are in straight line, the hook fixed on the upper drag link catches the lower drag link to prevent the drag link from being folded.

(2) Operation (Fig. 3-17, 3-18)

A,B. As the actuating cylinder retracts, the bellcrank fixed on the top of the upper drag link rotates (main 7°30', nose 5°), pulling the hook until it releases the down-lock.

C. As the clutch is in contact with the bellcrank, the action of the actuating cylinder is transmitted to the drag link which, therefore, is folded. Subsequently, the landing gear is retracted, and the drag link also is folded automatically.

D,E. While lowering the gear, the bellcrank rotates at the beginning of operation of the actuating cylinder, and the aforementioned play (main 7°30', nose 5°) is transferred to the other side. The clutch plate, utilizing the rotating force, releases the drag link for gear extension.
As the lower drag link is extended, the hook comes in touch with the lower drag link which pushes the hook back. The hook, however, can not be pushed further because the hole in the rod end is slender.

F. When the drag link has been fully extended, the hook comes to the lock position by the spring.

(3) Assist Spring

The assist spring pushes the drag link in the direction of the drag link extension; in case of free fall, the assist spring assists the drag link to take a straight line securaly; on the ground, the assist spring prevents the drag link from being folded.

(4) Adjustment

A. Nose Gear Down Lock (Fig. 3-20)

(A) Adjustment before installation of the drag link.

Keeping the drag link in a straight line:

a. Adjust the clearance ⟨A⟩ using the shim (1).

b. Adjust the clearance ⟨B⟩ using the shim (2).

(B) Adjustment after the installation of the drag link.

Jack up the aircraft and relieve hydraulic pressure.

a. Pull the drag link forward by its center. When the ⟨A⟩ of both upper and lower drag links have come into contact with each other, adjust the clearance ⟨C⟩ by the stop bolt (4).

b. Adjust the rod (6) so that the lever (5) will be horizontal.

c. Adjust the clearance ⟨D⟩ by the rod (7).

d. Apply hydraulic pressure and make check Lock-Unlock operation of the down lock by operating the landing gear control lever.

B. Main Gear Down Lock

(A) Adjustment before installation of the drag link.

Keeping the drag link in a straight line.

a. Adjust the clearance ⟨A⟩ using the shim (1).

b. Adjust the adjust screw (2) so that it will come in contact with the plate (3).

(B) Adjustment after installation of the drag link.

Jack up the aircraft and relieve hydraulic pressure.

a. Pull the drag link forward by its center. When the adjust screw (2) has hit the plate (3), adjust the stop bolt (4) so that clearance ⟨B⟩ is within the specified limits.

b. Adjust the length of the rod (5) to 6.15 in.

c. Pull the drag link forward by its center, and adjust the rod (6) so that the clearance ⟨C⟩ is within the specified limits.

d. Apply hydraulic pressure, and check Lock-Unlock operation of the down-lock by operating the landing gear control lever.

3.4.7 Up Lock Mechanism

(1) General

Each gear is locked mechanically in its up-lock position and unlocked hydraulically. The construction and operation of the three gears are almost identical. The up-lock mechanism consists of the hook, link, lever and a couple of springs. The up-lock switch is operated by an arm attached to the lever.

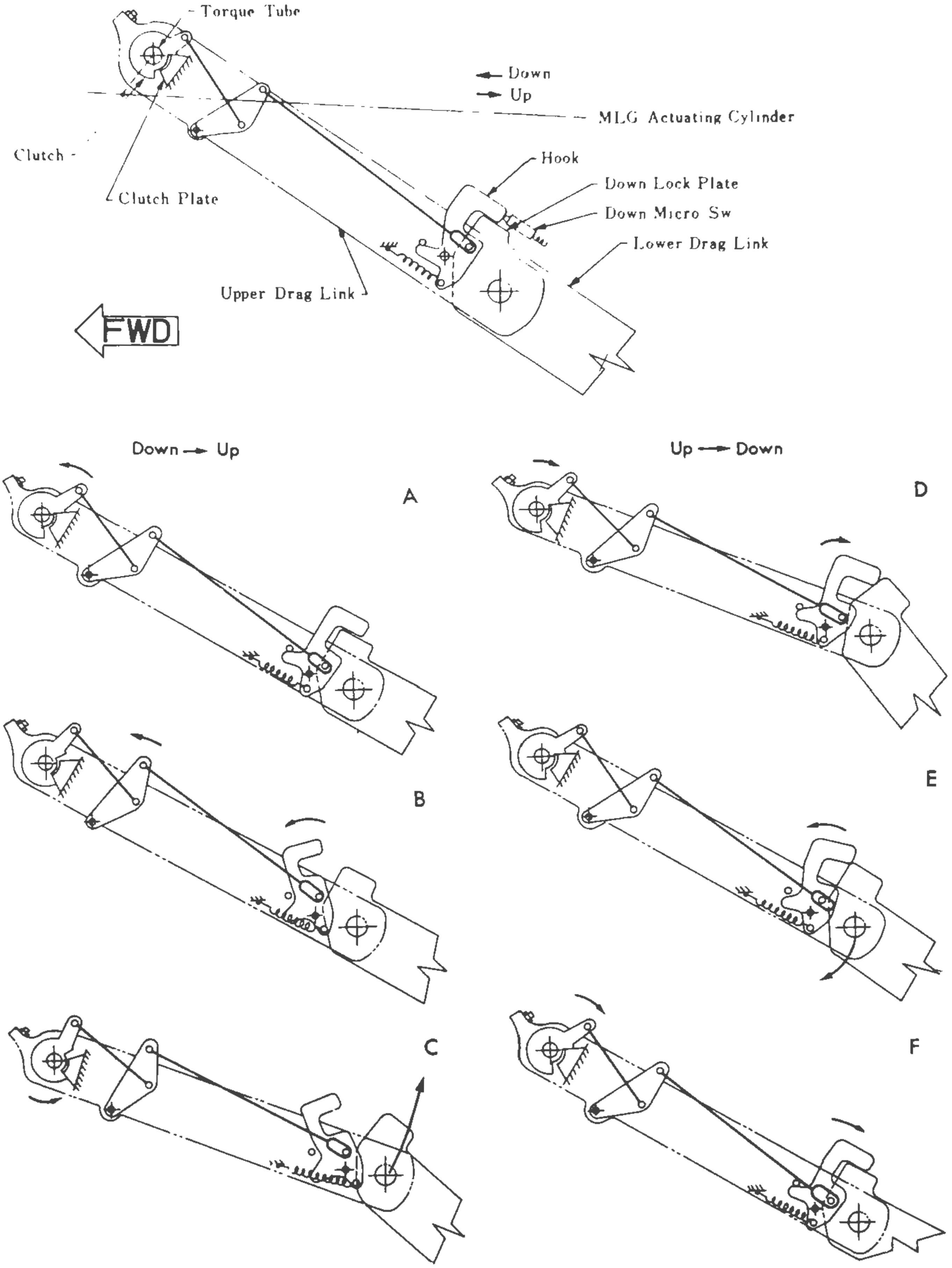
(2) Operation (Fig. 3-21, 3-22)

A. Gear Retraction

(A) The springs E and C hold the link mechanism ABCD in the alignment. The roller of the main gear shock strut comes up to push upward the hook at the upper jaw.

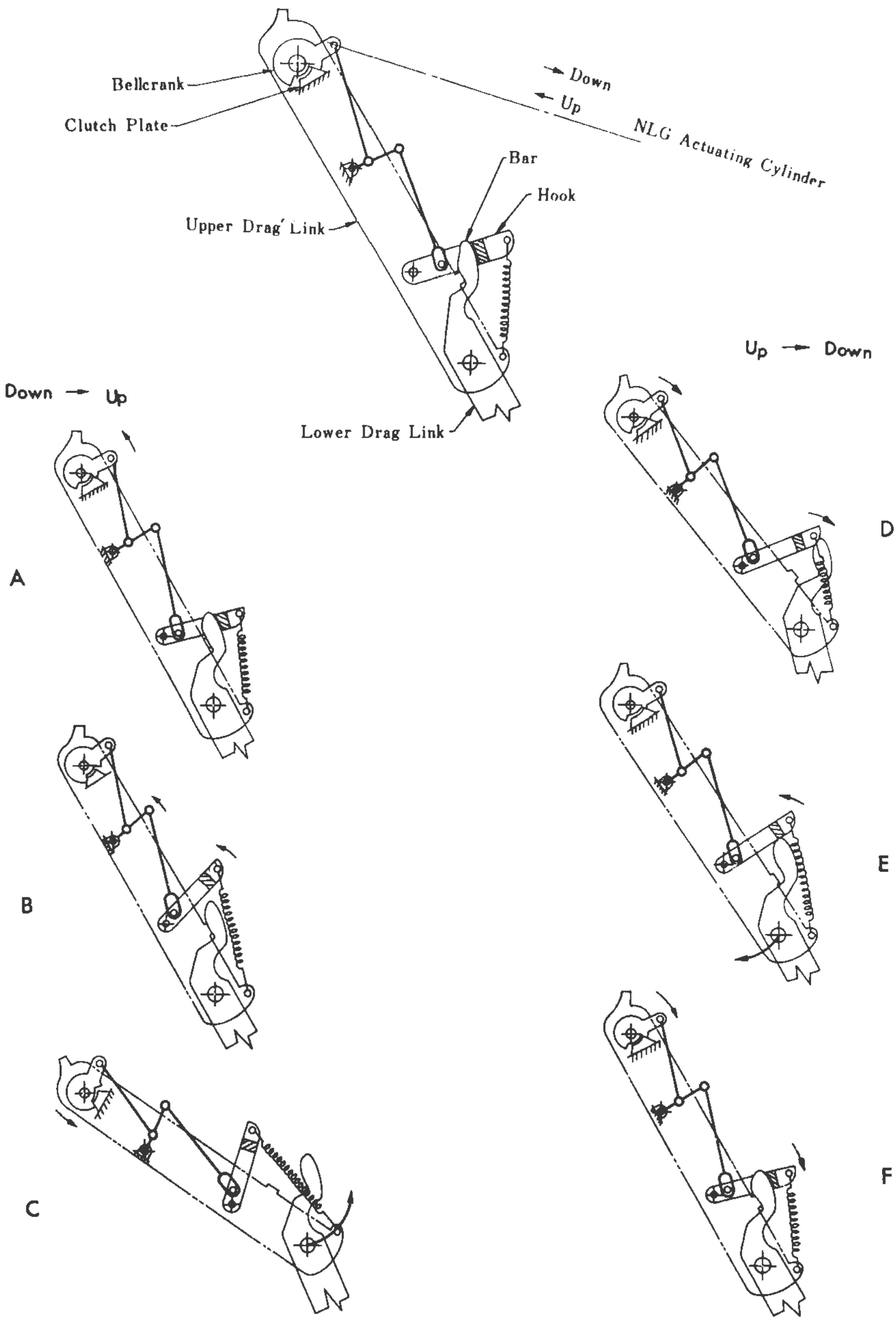
(B) When pushed upward, the hook rotates counterclockwise while extending the springs. So, the point C is pulled downward and the line connecting the points E, B and C becomes straight.

(C) As the hook rotates further, the point B is forced to the right of the line of the springs E and C; and accordingly the hook is suddenly rotated by the springs until it hits the stop bolt. As hydraulic pressure is relieved, the shock strut is lowered with its own weight, and the roller tends to rotate the hook. However, since the line of A B C is over-centered, the hook is not allowed to rotate.



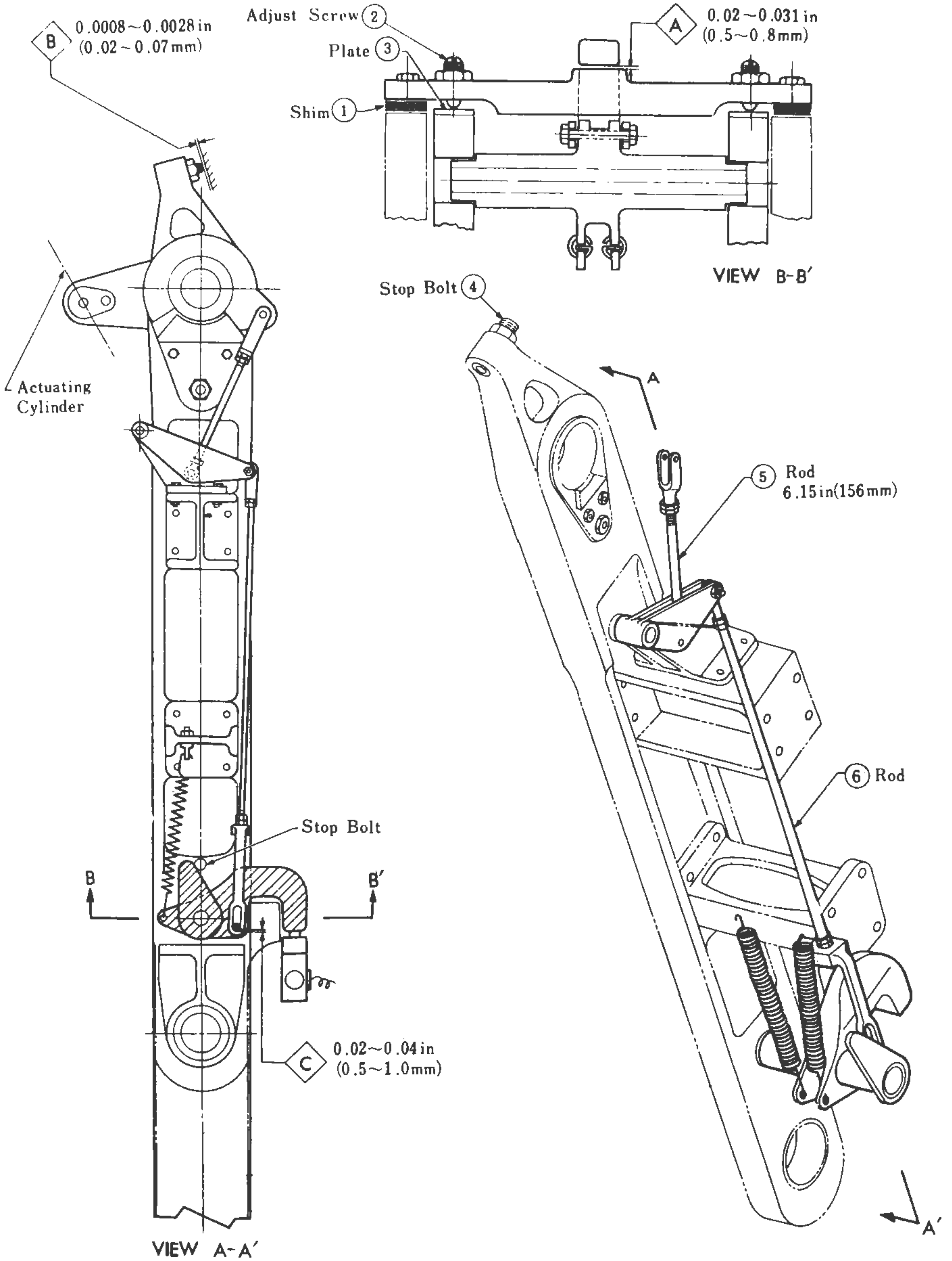
Main Landing Gear Downlock Mechanism

Figure 3–17



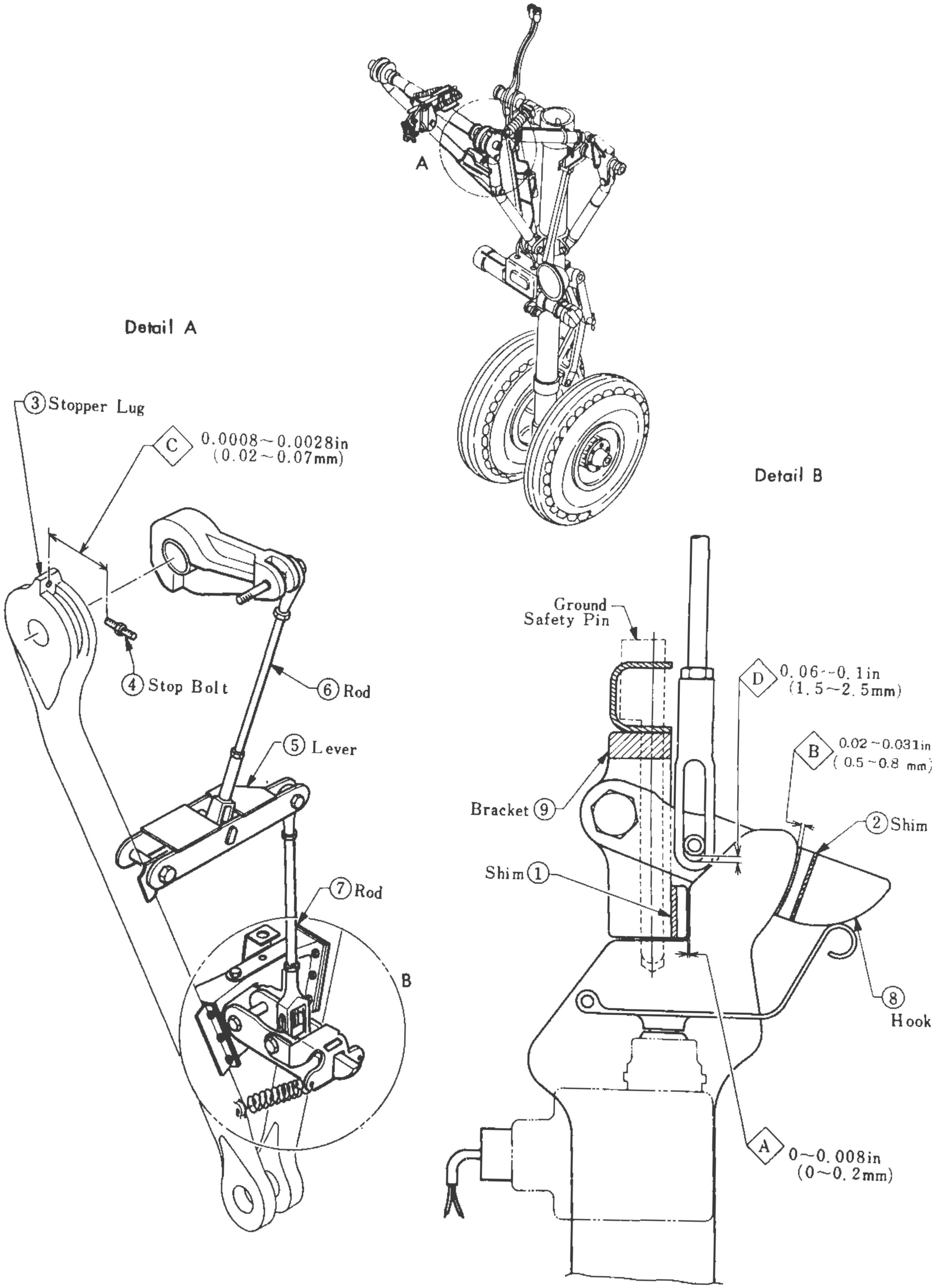
Nose Landing Gear Down Lock Mechanism

Figure 3–18



Adjustment-MLG Down Lock

Figure 3–19



NLG Down Lock Adjustment

Figure 3–20

(3) Adjustment

A. Nose Gear Up Lock (Fig. 3-23)

(A) Set the up-lock to the lock position, and adjust the stop bolt so that the clearance ⟨A⟩ is within the specified limits.

(B) Return the up-lock to the unlock position, and raise the gear. Make certain that the roller (6) does not come in contact with the top end of the hook.

(C) Check the clearance ⟨B⟩ and make certain the function of the bumper.

(D) Adjust the shim (7) so that the clearance ⟨C⟩ is within the specified limits.

B. Main Gear Up Lock (Fig. 3-24)

(A) Adjust the length of the link (1) to approximately 0.35 in.

(B) Set the up-lock to the lock position and adjust the stop bolt (2) so that the clearance ⟨B⟩ is within the specified limits.

(C) Unlock the up-lock and raise the gear. Adjust the shim (5) so that the clearance ⟨C⟩ is within the specified limits.

(D) Check the clearance ⟨E⟩ and make certain that, the function of the bumper.

3.4.8 Main Gear Door Actuating Mechanism

(1) General

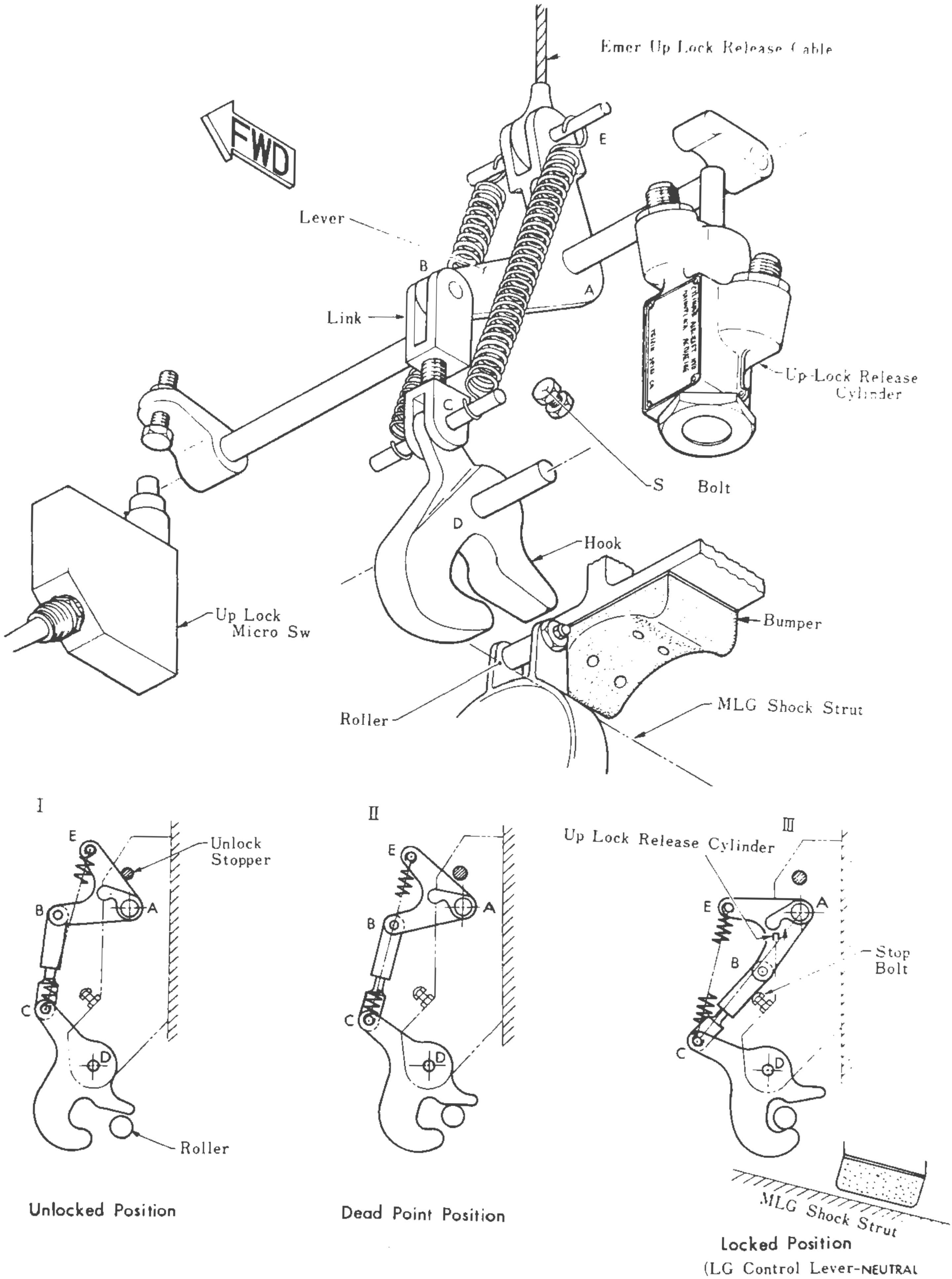
The main gear door is attached to the airframe with three hinges. The door is of double skin construction and the airplane can fly at airspeeds up to 245 kt (EAS) with the door open (landing gear down). The door actuating mechanism consists of the rod, bellcrank, arm, bar, guide and spring. The neutral position of this link mechanism is between the position II and III in Fig. 3-25, that is, the position of the saddle BC is about 2 in. higher than that of III.

The door will be locked open when the saddle BC comes down over the centerline of AD. (BC is overcentered)

(2) Operation (Fig. 3-25)

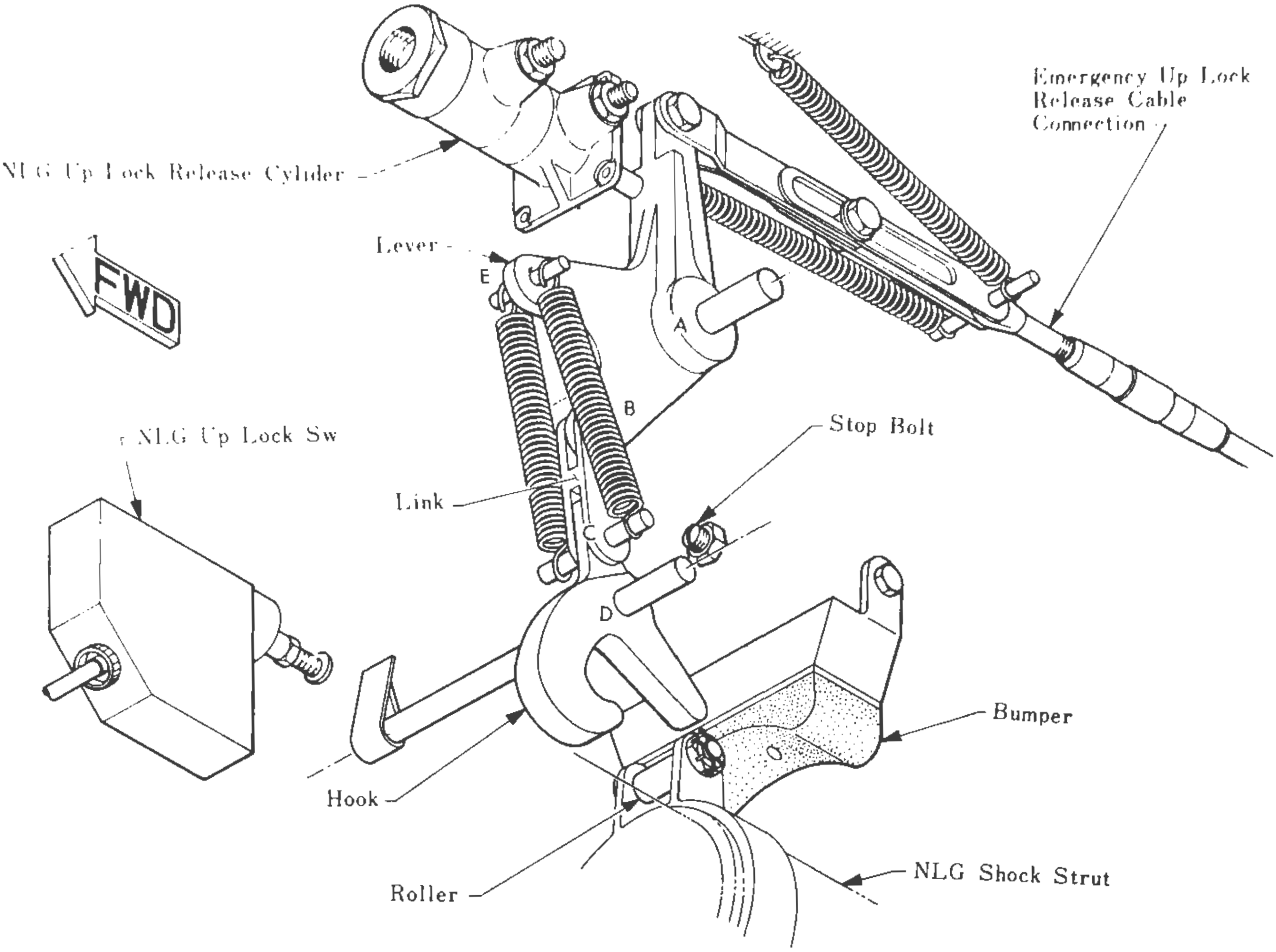
A. Gear Retraction

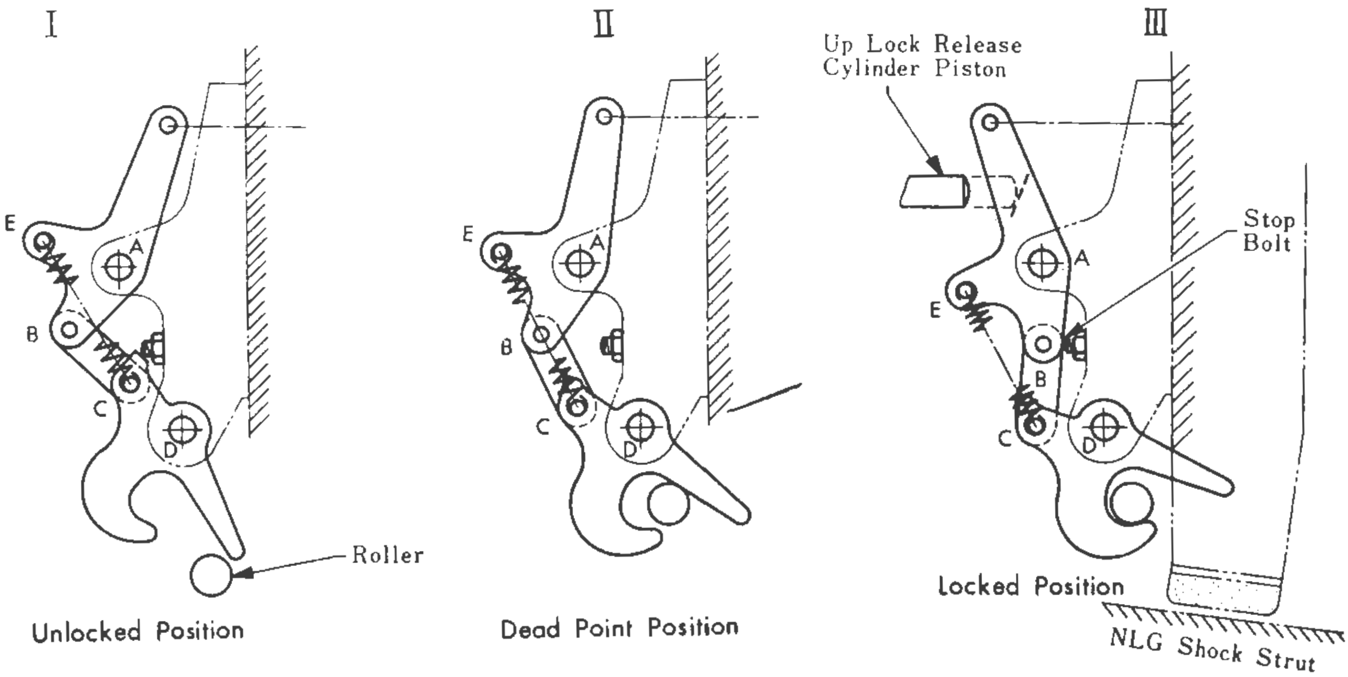
The roller attached to the main shock strut pushes the saddle upward and the door is closed in a sequence from IV to III, II and finally to I.



Main Landing Gear Uplock Mechanism

Figure 3-21

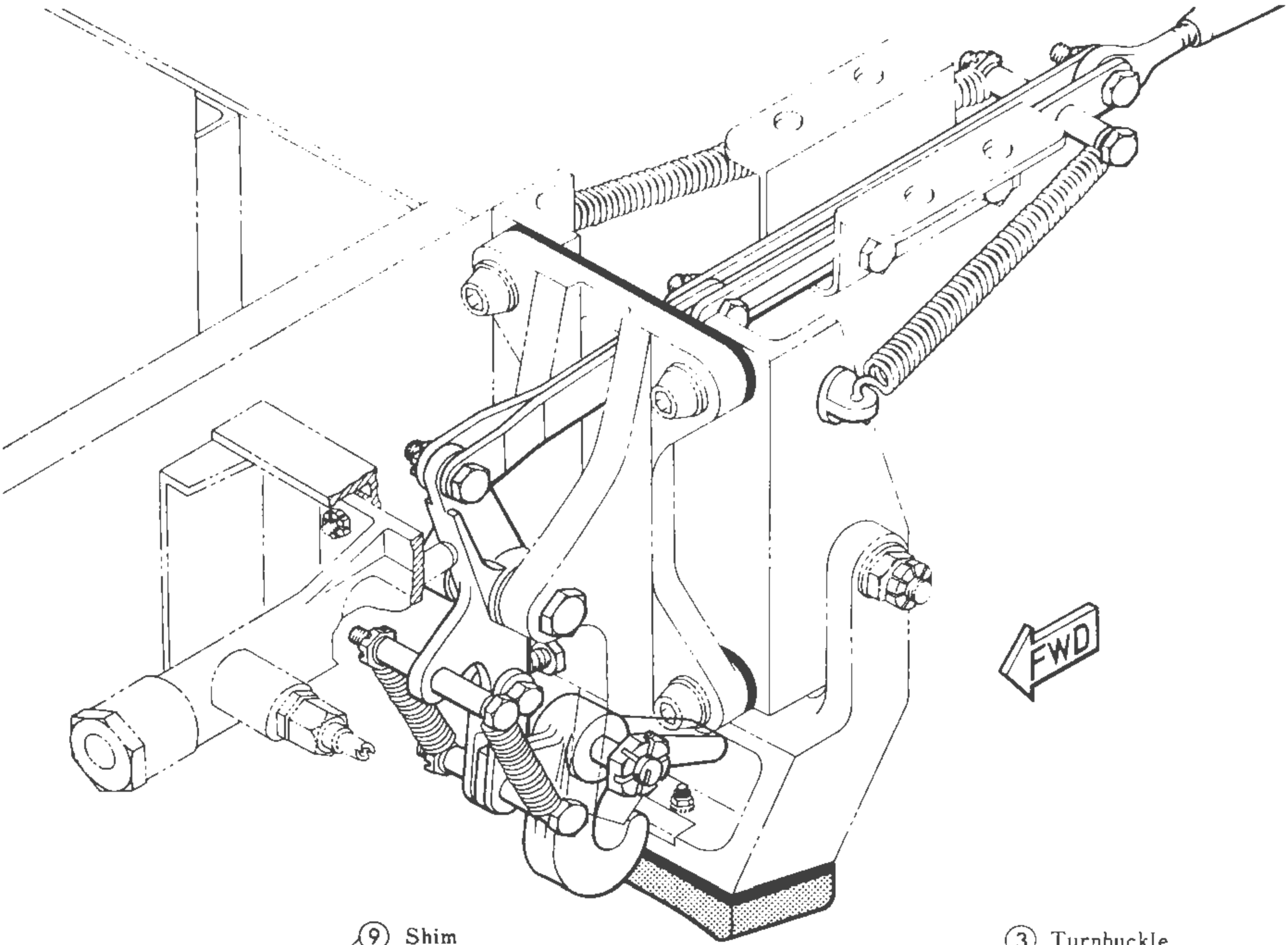


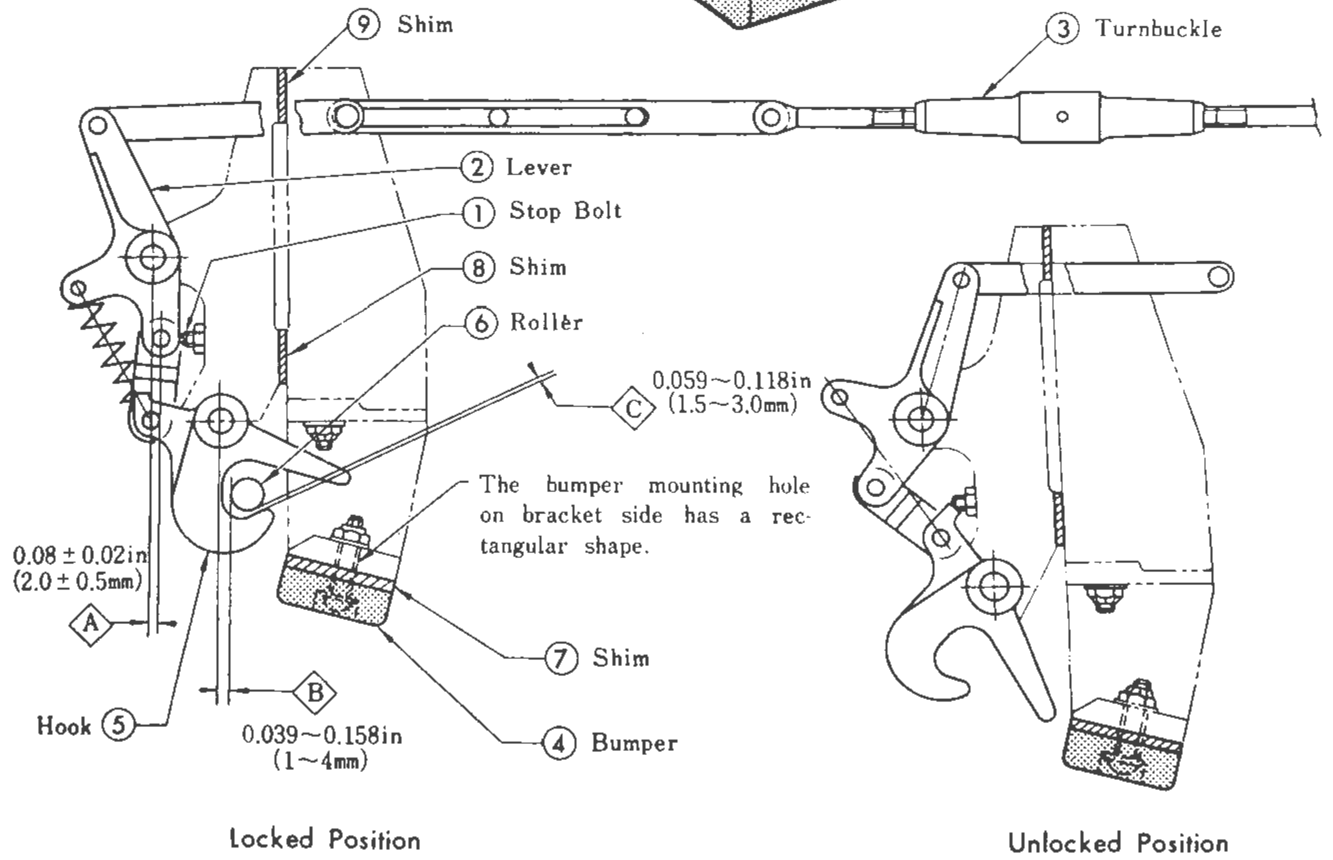


(LG Control Lever-NEUTRAL)

Nose Landing Gear Uplock Mechanism

Figure 3–22





Nose Landing Gear Up-Lock and Bumper

Figure 3–23

The door does not have its own up-lock mechanism, however, the gear is locked in up-lock position locking the door indirectly in its up-lock position. (Closed position)

B. Gear Extension

As the main gear is extended, the roller goes into the hook to push it downward. Thus, the door is opened in a sequence from I to II, III, and finally to IV. At the position IV, the saddle is overcentered about 20 to 25mm and retained by the door spring.

(3) Adjustment (Fig. 3-26)

A. Detach the door spring and the adjust link (1) from the door linkage.

B. Adjust the lengths of the hook assembly (2) and arm assembly (3) and the stop bolt.

	Hook assembly and arm assembly	Stop bolt
Outboard	263 mm	23 mm
Inboard	232 mm	33 mm

C. When the landing gear is up and the door is at a standstill after overcentering, the clearance Ⓐ between the shock strut roller (8) and the guide (7) shall be 2.0mm at least and the hook (2) is set back from the guide (7) by 0.5 to 1.3mm. Adjust the serrations so that the difference of the clearances between the L.H. and R.H. (outboard and inboard) rollers and the guide is not more than 0.5mm.

Fine adjustment not more than 0.038in may be made by the stop bolt.

After the adjustment, make alignment marks on the serrations.

D. Reduce the clearances of the stop bolts to zero under the conditions described in para. C. While keeping the clearances zero, extend the bolts (both inboard and outboard) by 1/4 turn to preload them.

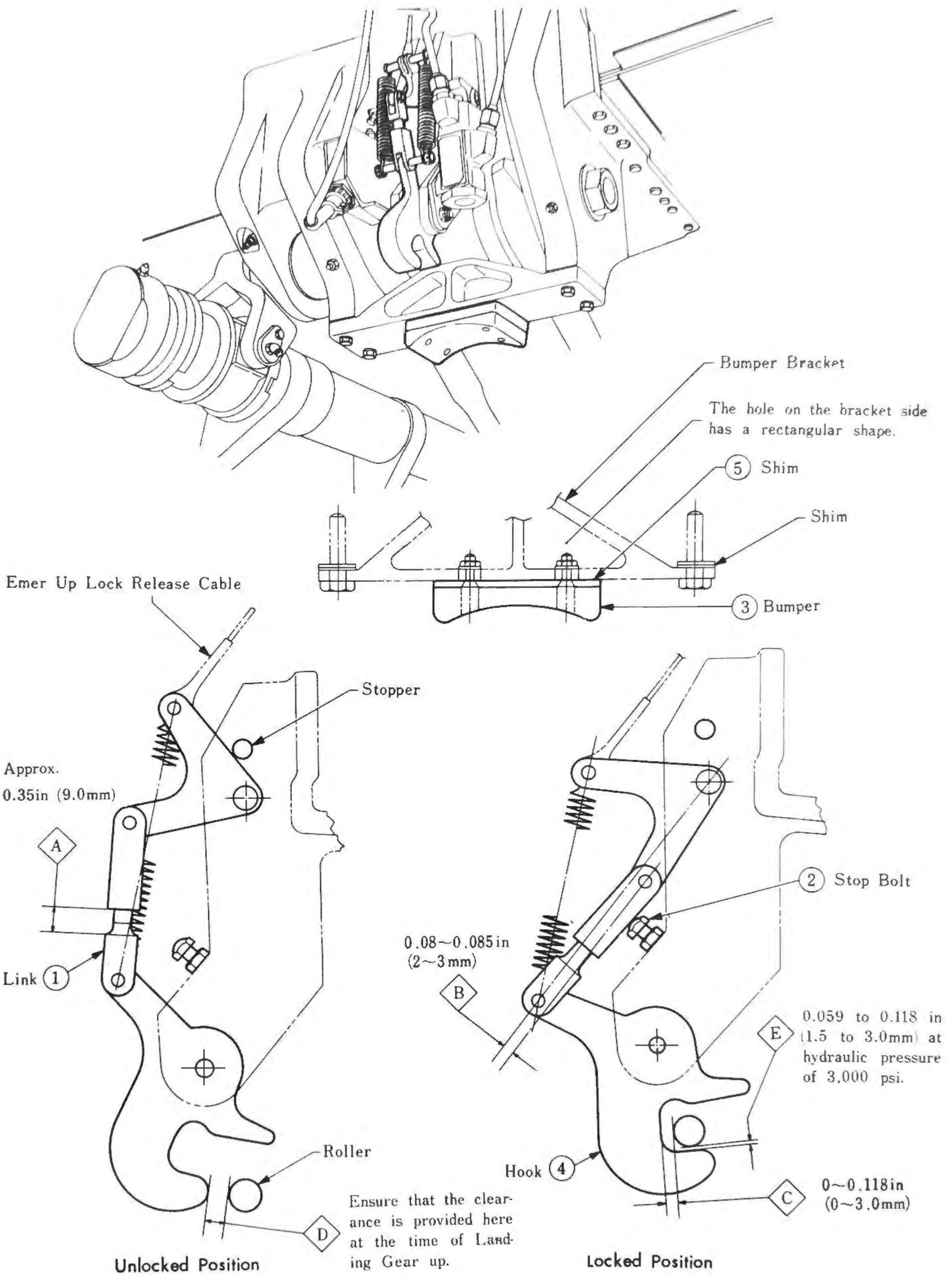
E. With the landing gear down, connect the door spring and the adjust link.

F. Adjust the adjust link so that the door and the nacelle contour are flush when the door is fully closed.

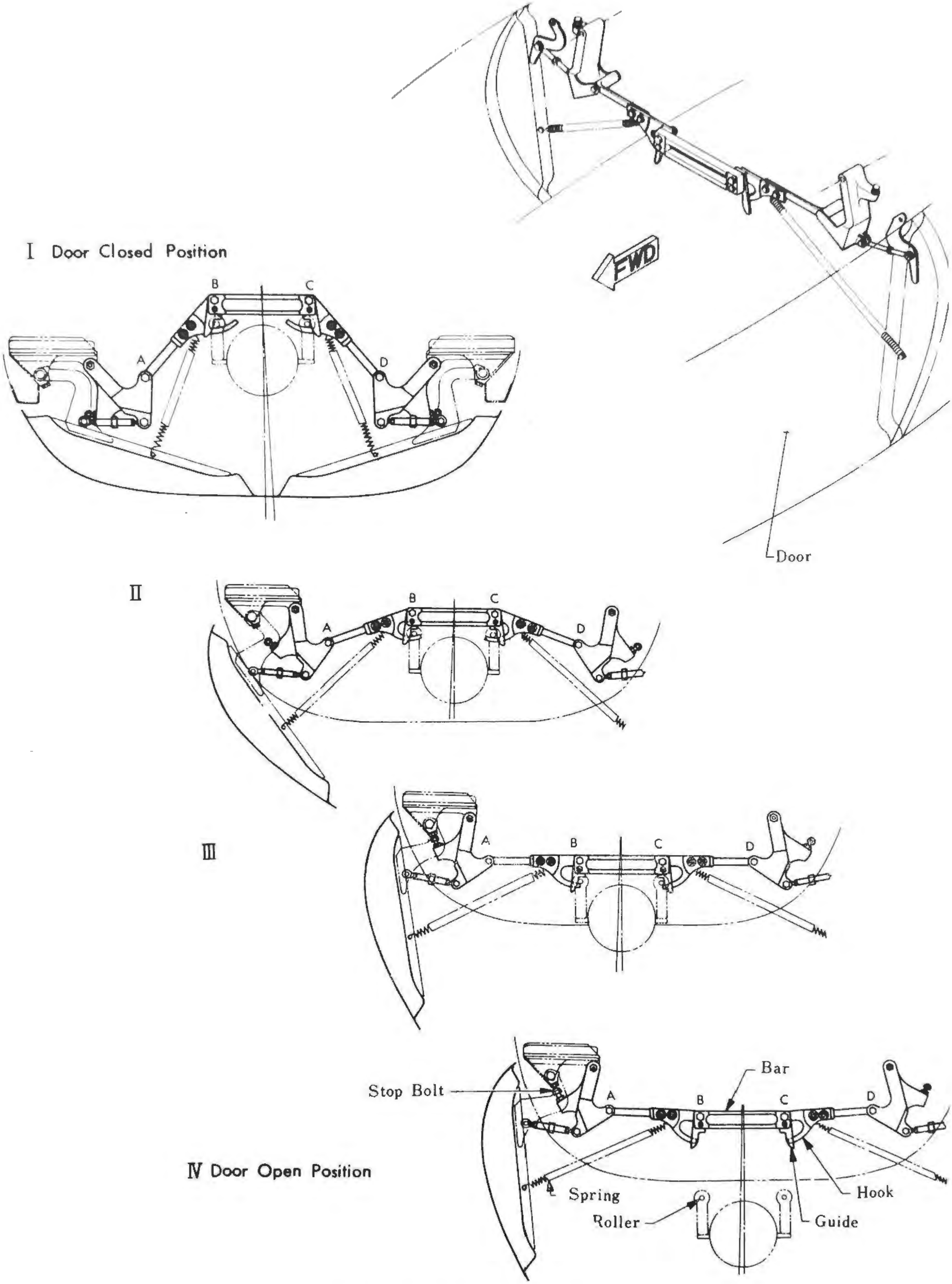
3.4.9 Nose Gear Door Actuating Mechanism

(1) General

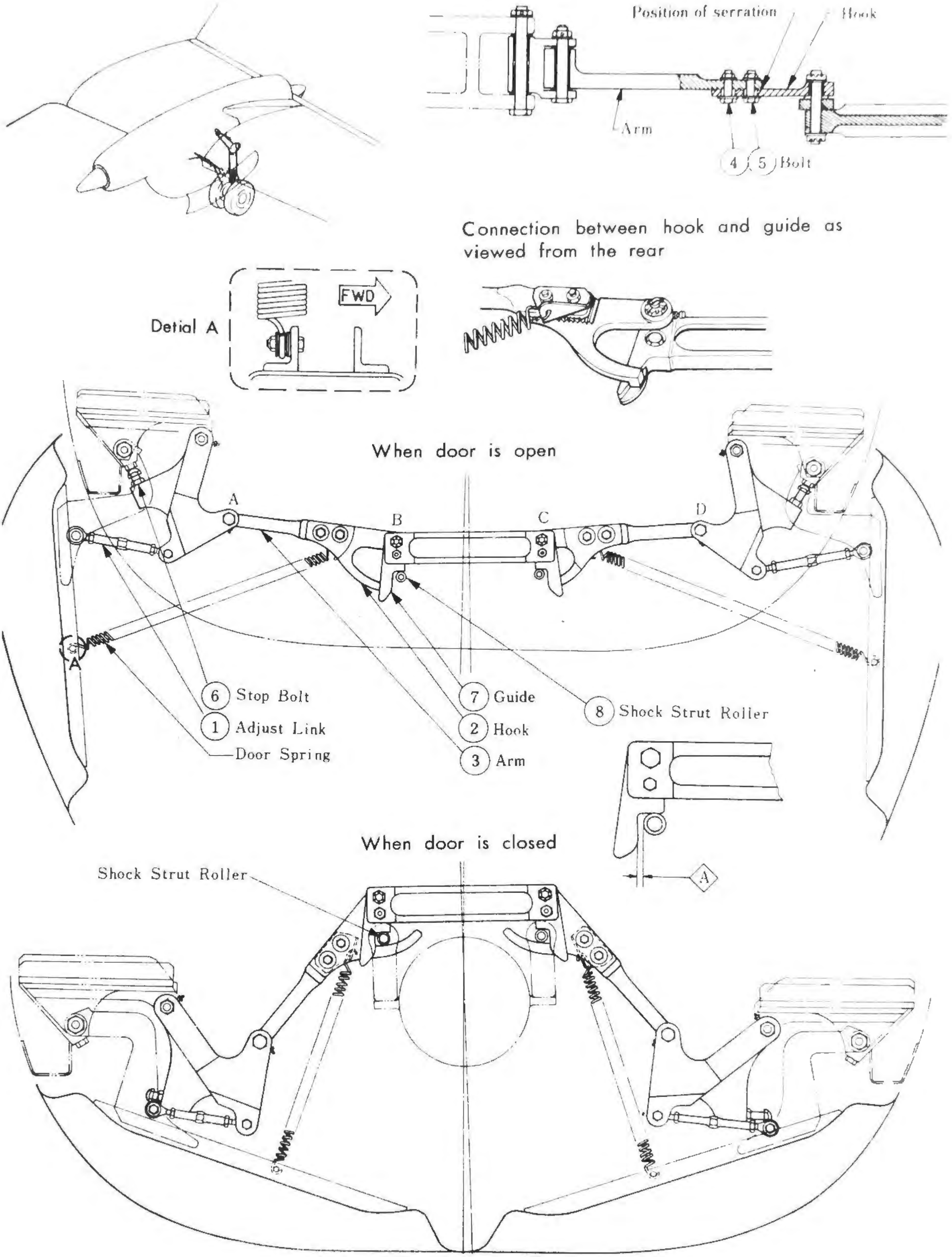
The nose gear door is attached to the airframe with three hinges. The actuating mechanism consists of rod, saddle, lever, cam and brace; and the lower end of the mechanism, i.e., the rod end, is fixed to the door. The link mechanism is supported by the brace fixed to the wall of the gear well.



Adjustment-MLG Up Lock
Figure 3–24



Main Landing Gear Door Actuating Mechanism
Figure 3–25



Rigging-Main Gear Door Actuating Mechanism
Figure 3–26

(2) Operation

A. Gear Retraction

D: The levers are held open by the springs securing the cam, so, the rod can not be folded.

C: The inner cylinder of the nose shock strut pushs up the lever, accordingly, the roller of the lever comes up to the end of the side arc of the cam.

B,A: As the shock strut is raised, the saddle pulls up the rods which, accordingly are turned inwards; and the clevis pushes up the cam, and the roller turns from the side arc to the end arc of the cam, and the door is fully closed.

B. Gear Extension

As the shock strut is lowered, the rods are turned outwards, accordingly the clevis functions to pull the cam to turn and the roller comes up to the end arc of the cam. The roller further moves to the side arc of the cam. When the door has been fully opened, there comes a slight clearance between the roller and the cam. Thus, the levers are opened to let the shock strut fall down freely from the door link.

(3) Adjustment

A. Adjustment before installation of the door linkage.

(A) Make the left and right levers (1) grasp the shock strut and adjust the shim (3) so that the levers and the stop assembly come in contact uniformly with the shock strut.

(B) Adjust the stop bolts (4) so that clearance A is within the specified limits when the levers are fully opened.

B. Adjust the stop bolts (5) so that it may be in contact with the stopper with the doors fully opened but not in contact with the fuselage skin.

C. Install the door linkage.

D. Raise the landing gear slowly and make certain that the clearance A is within the specified range; at the same time, adjust the shim (8) so that the clearances on both sides are equal.

E. Make certain that the rubber of both the stop assembly and the lever are in uniform contact with the shock strut.

F. With the gear up-locked and the control lever in the "NEUTRAL" position, adjust the rods (6) so that the doors can be closed tightly.

G. Lower the gear, adjust the clevis (12) and the stop bolts (5) to minimize the clearance ⟨B⟩.

H. Adjust the stop assembly so that the clearance between the side brace of the shock strut and the stop assembly (13) is 0.197 to 0.394 in (5 to 10 mm)

I. Operating the gear up and down, make certain that the clearance between the door and the steering cylinder is more than 0.276 in (7 mm) on both sides.

3.4.10. Emergency Up Lock Release System

(1) General

The emergency up-lock release system releases the up-locks manually in case of the hydraulic system failure.

The emergency up-lock release handle is located at the front part of the right console. A cable extending from this handle is branched off into three which are connected to the up-lock levers of the respective gears. The pulling force transmitted to the lever from the handle is eight times the force needed to pull the handle. The cable installation is so designed as to provide some slackness or play necessary for the normal operation of the gear.

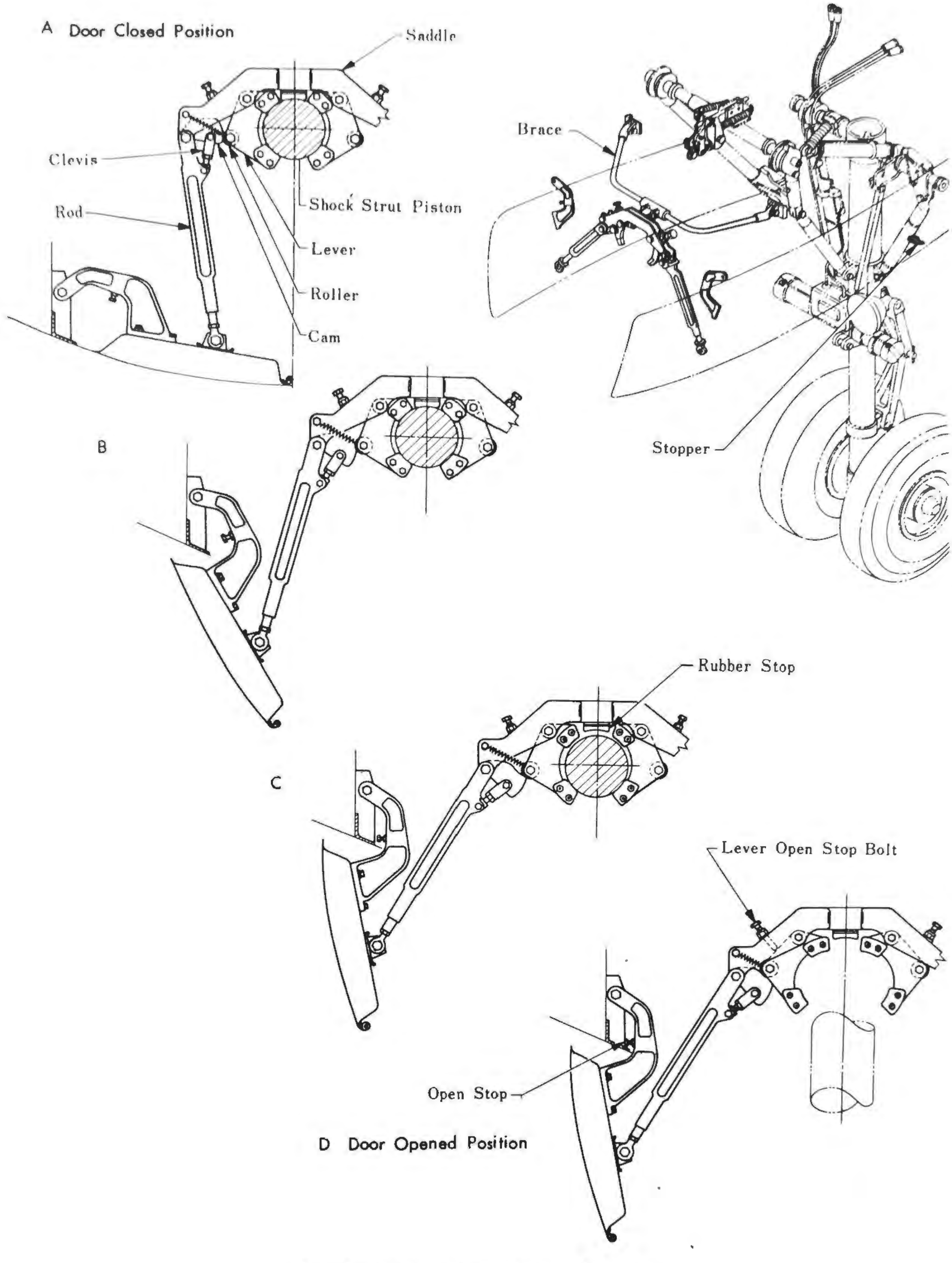
(2) Adjustment (Fig. 3-30)

A. Take off the floor plate CIR in the cockpit and insert the rig pin (2) into the sector (1).

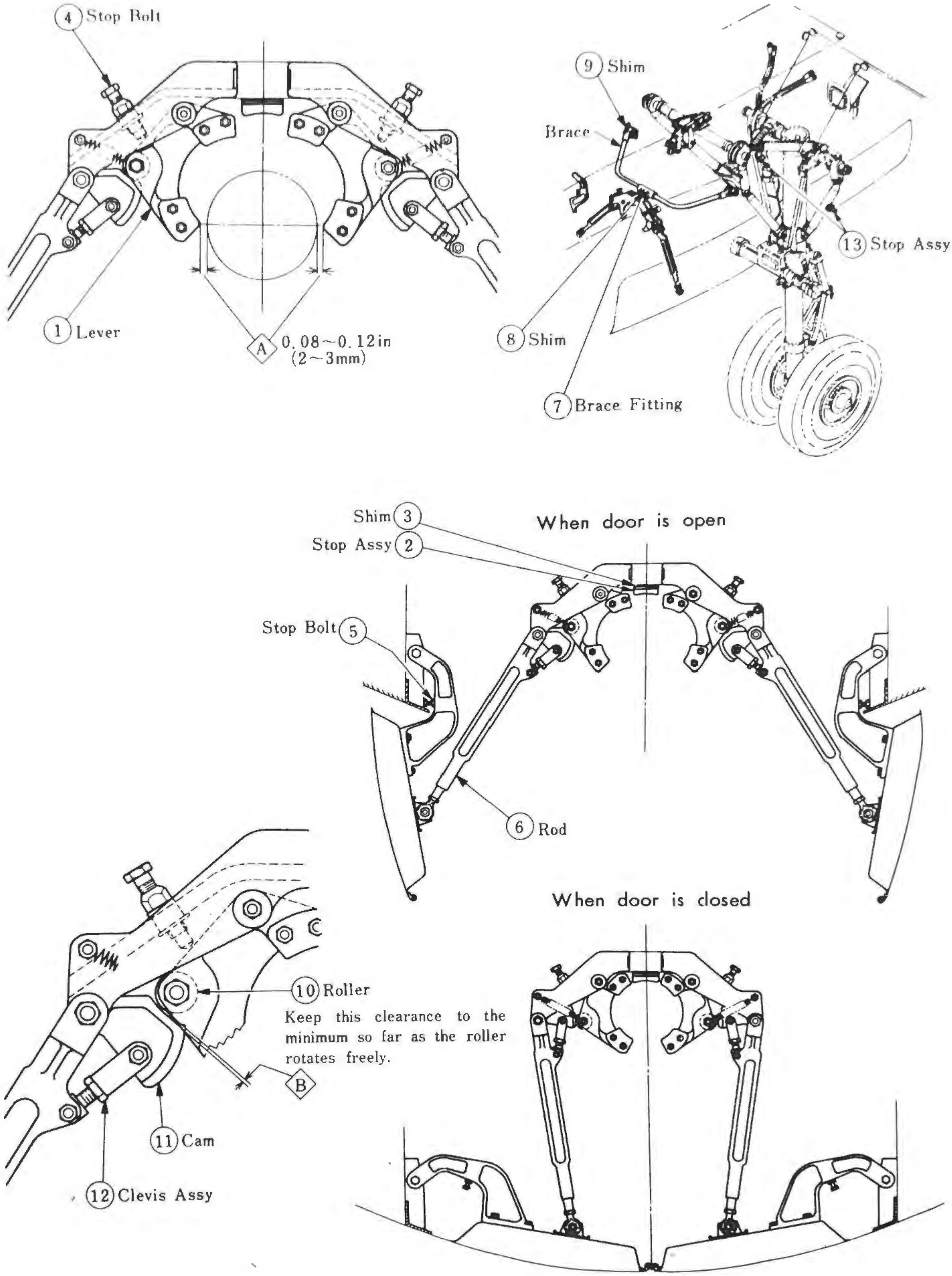
B. Adjust the turnbuckle (3), (4) and (5), so that the clearance at ⟨A⟩ and slackness at ⟨B⟩ are in existence.

C. Adjust the turnbuckle (7) to such an extent that the rig pin (2) can be pulled out easily.

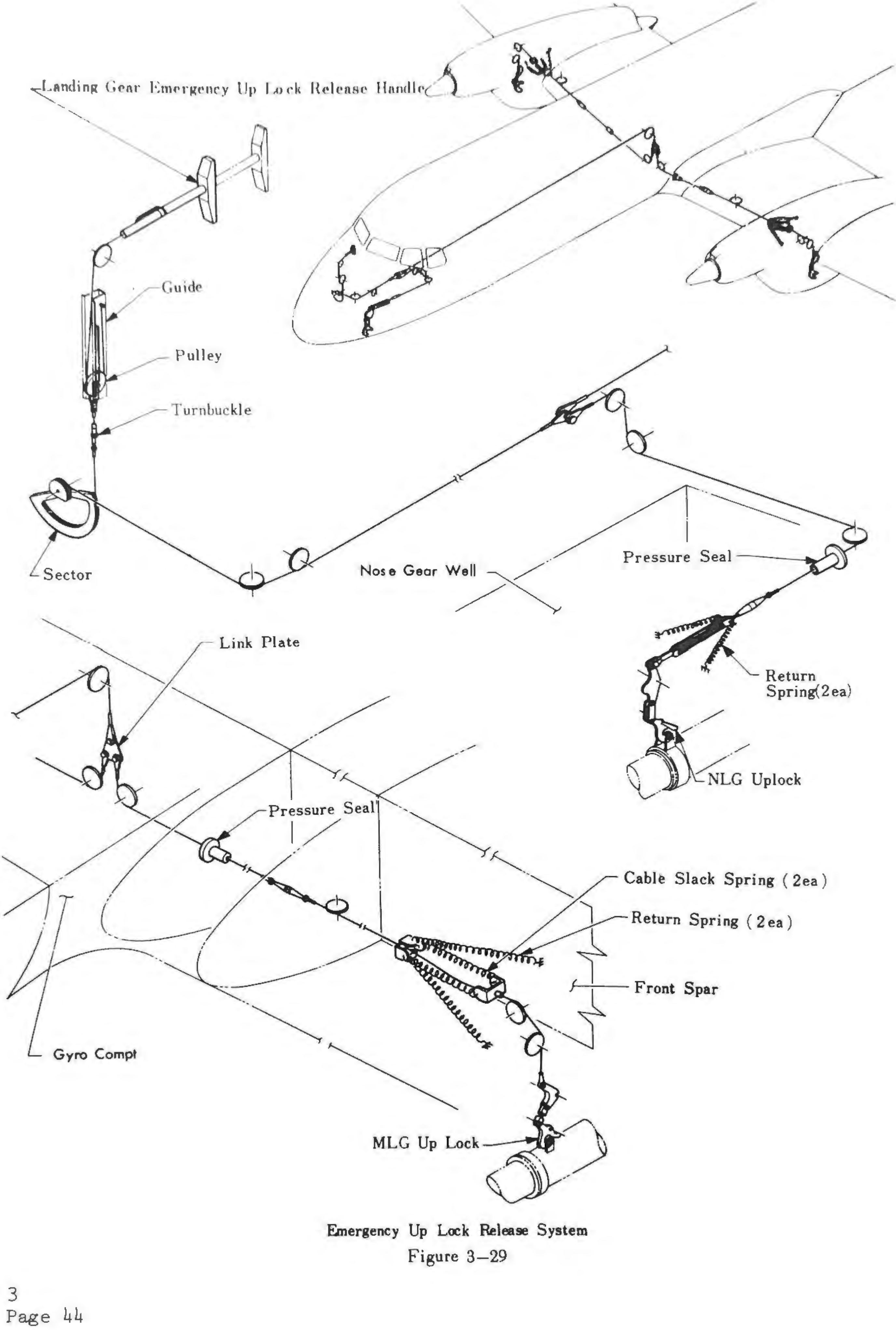
D. Pull out the rig pin (2) and pull the handle (6) fully to make certain that all up-locks are unlocked.



Nose Landing Gear Door Actuating Mechanism
Figure 3–27

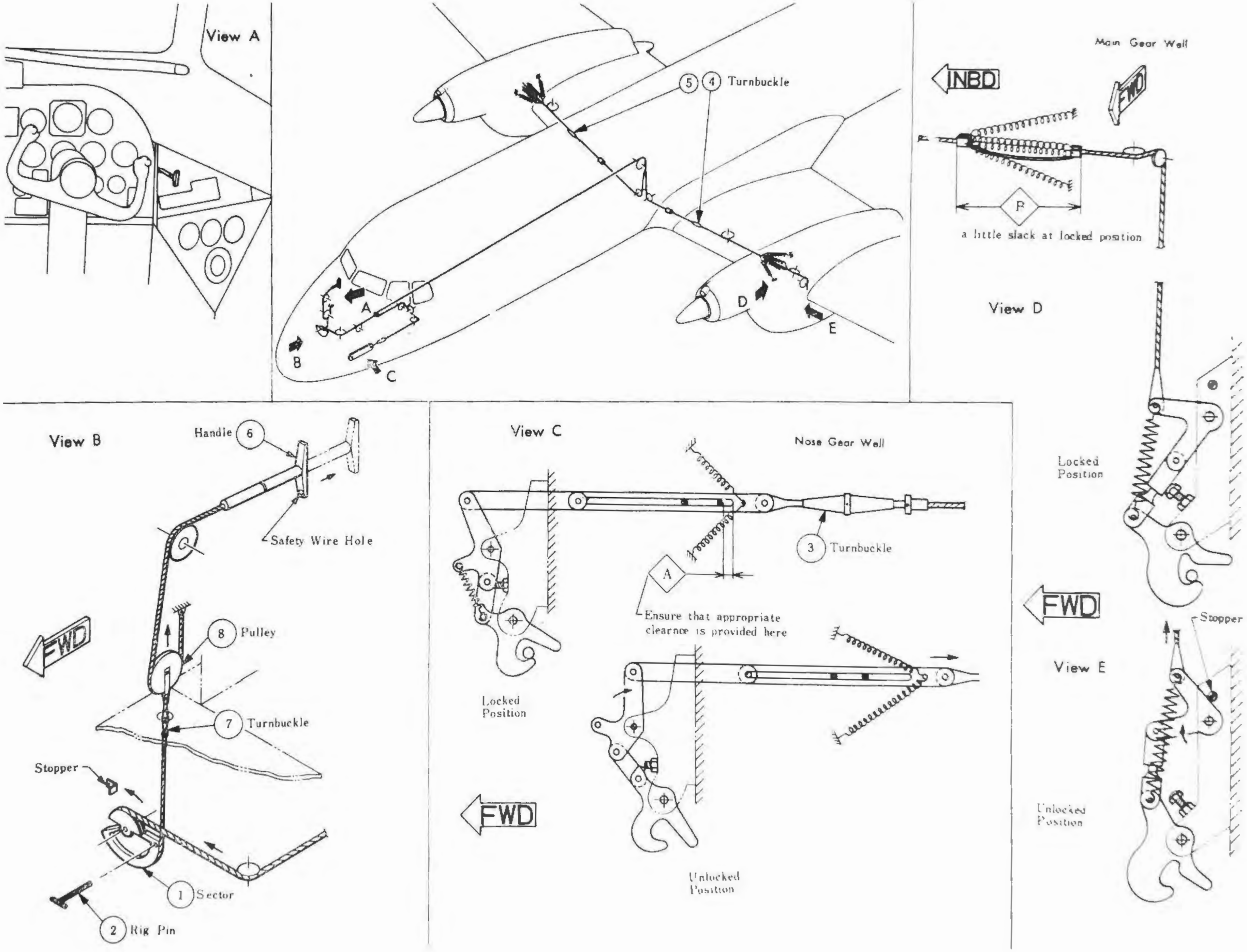


Rigging-Nose Gear Door Actuating Mechanism
Figure 3–28



Emergency Up Lock Release System

Figure 3–29



Emergency Uplock Release System Rigging
Figure 3-30

3.5 Wheel and Brake System

3.5.1 General

This system consists of the following sub-systems:

A. Normal and Parking Brake System

B. Emergency Brake System

C. Anti-skid System

D. Wheels

Both of the normal and emergency brake systems are designed to be operated hydraulically.

With the exception of the return line, these systems are entirely separated. The anti-skid system has been built in the normal brake system.

3.5.2 Normal and Parking Brake System

(1) General

The brake is of the conventional power brake type. Brake force in proportion to the travel of the brake pedal is applied to four brakes of the main gear.

The parking brake handle is located in front of the pilot seat. When the handle is pulled after the brake pedal is depressed, the brake pedal will be locked mechanically by the parking brake system.

(2) Operation (Fig. 3-31, 3-32)

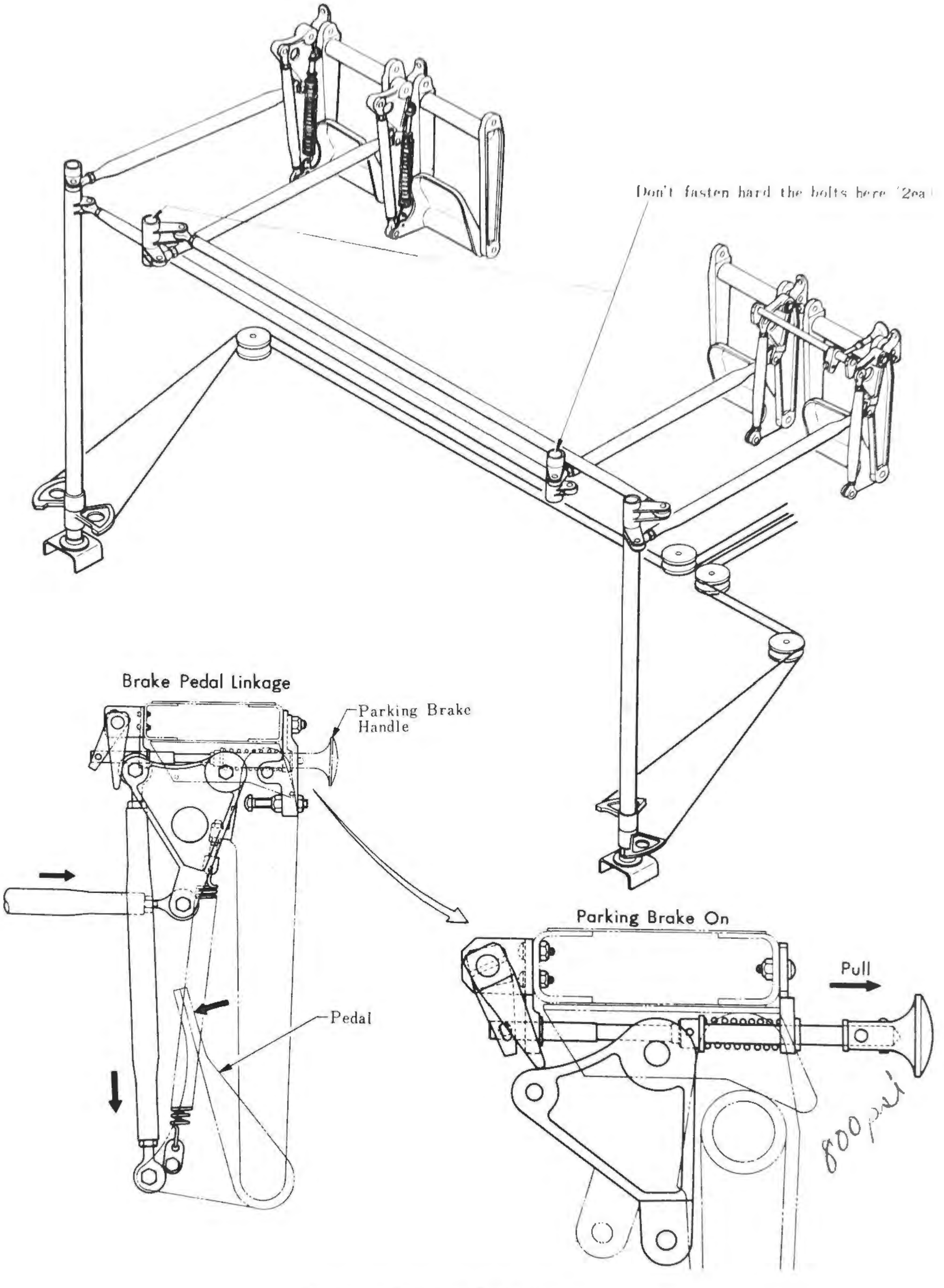
A. Depress the brake pedal, and the brake valve in the hydraulic compartment will be operated through the rod and cable.

B. Pressure oil coming from the brake valve flows to the swivel joint through the anti-skid valve. The swivel joint permits smooth extension and retraction of the gear without interfering with the pipe.

C. Pressure oil flows up to the top of the lock-out cylinder but never flows further beyond it. Hydraulic pressure, after being reduced at a ratio of 919/1000, is applied to the brake assembly. The maximum pressure to be applied is 1,200 $^{+100}_{-50}$ psi.

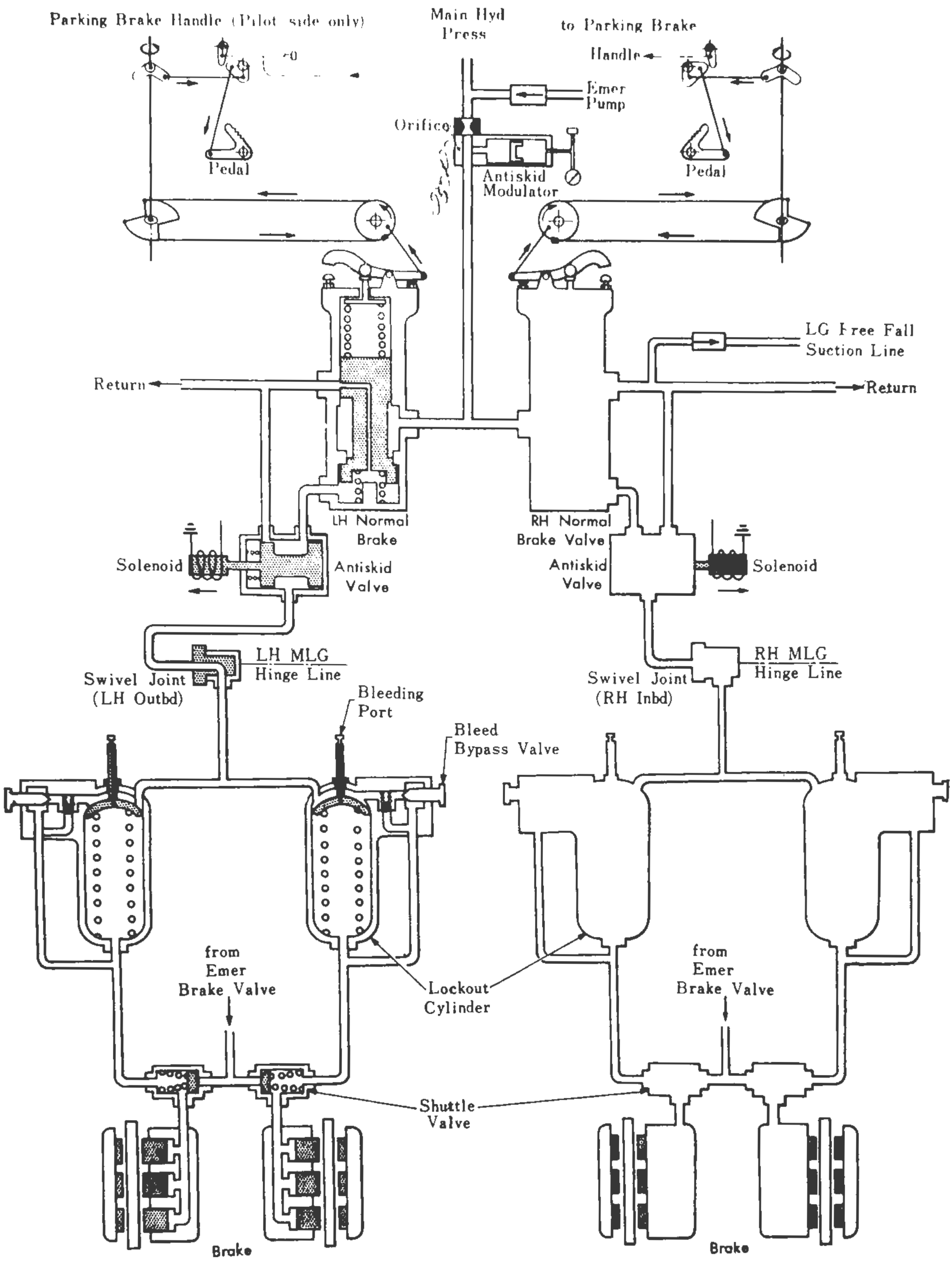
(3) Brake Valve

When the brake pedal is depressed, the roller of the lever pushes down the spring through the spring support. The spring, then, pushes down the spool supplying pressure oil to the brake port. When the



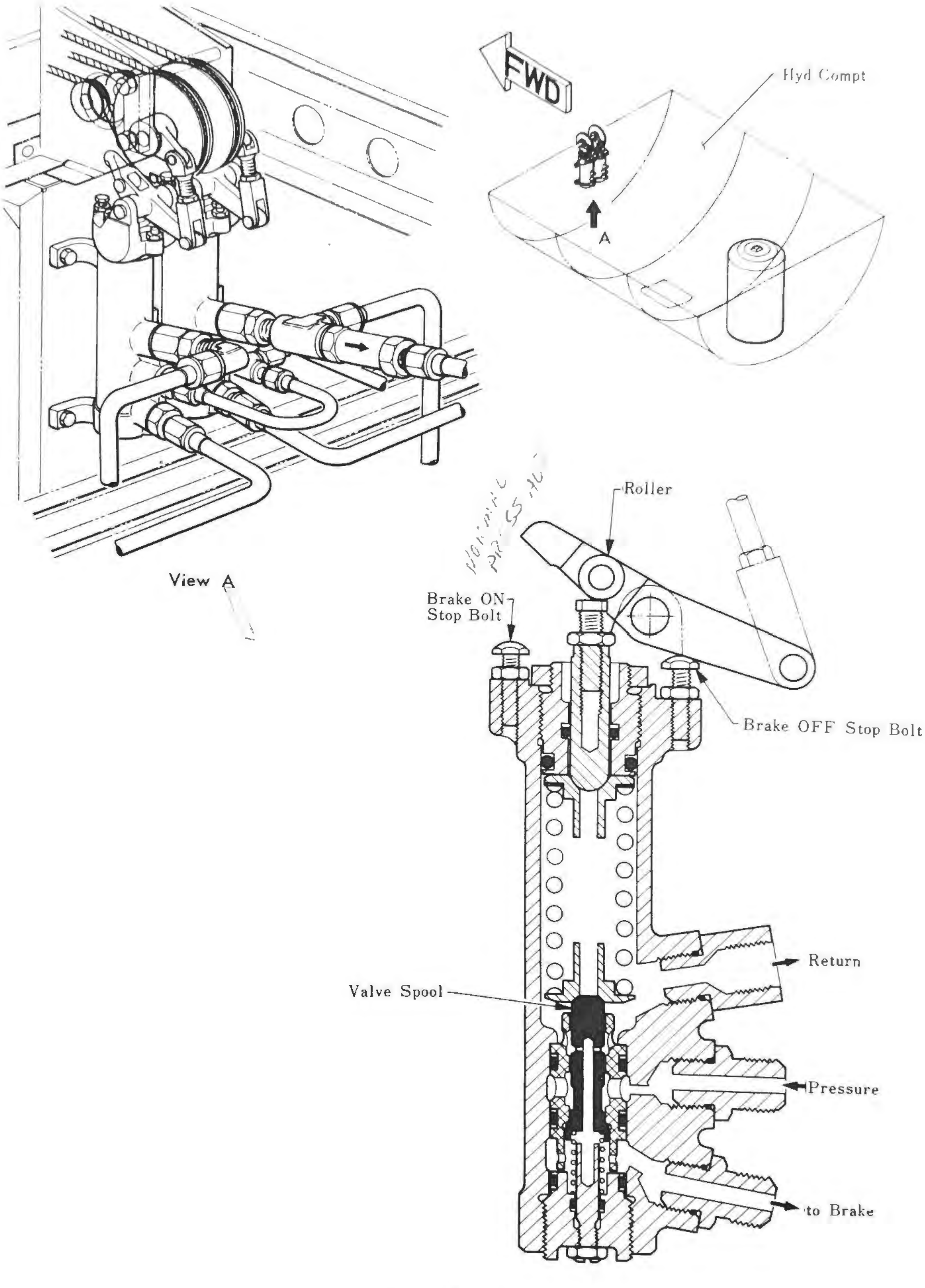
Normal and Parking Brake Linkage

Figure 3–31

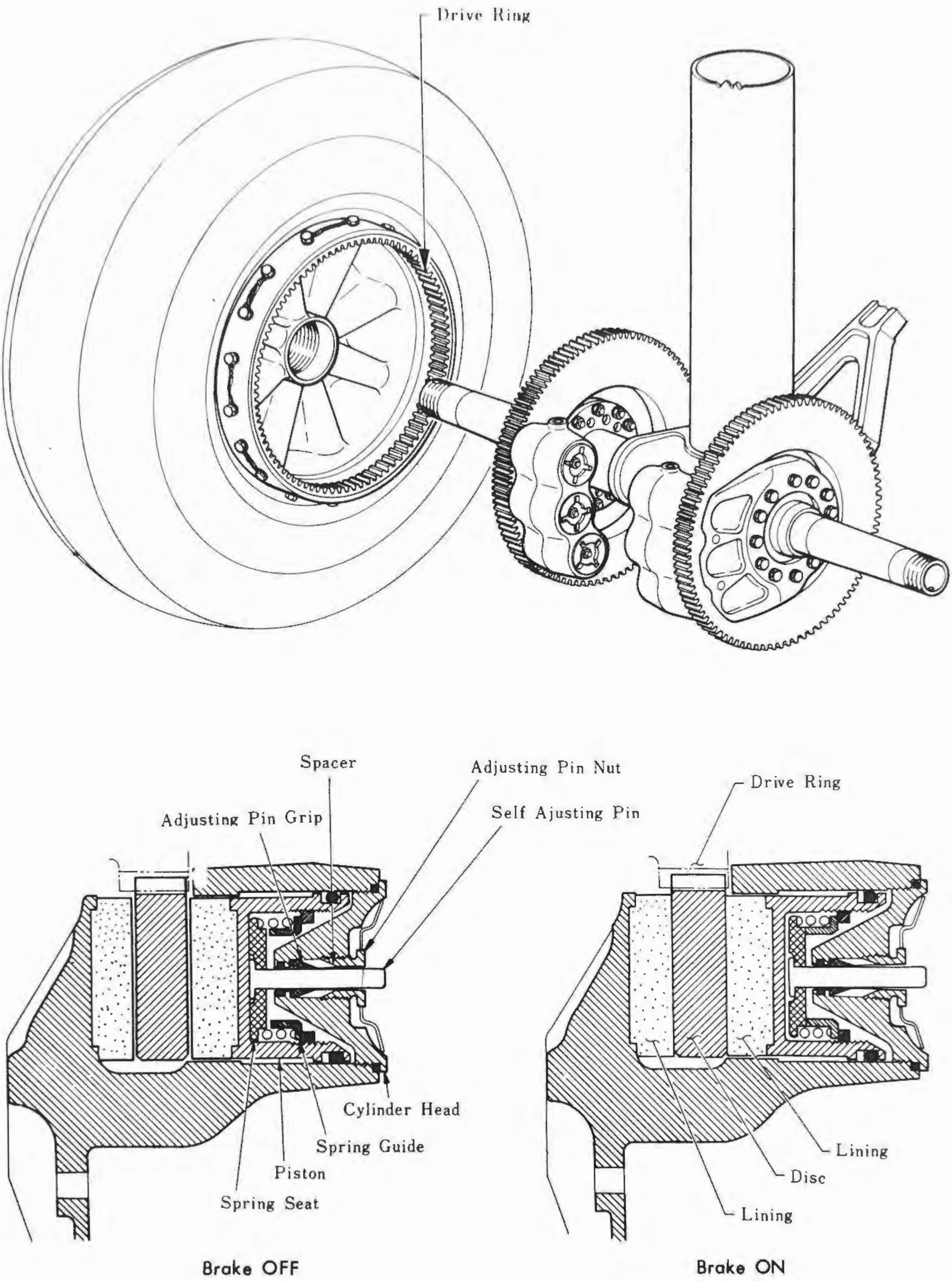


Normal & Parking Brake Hyd Schematic

Figure 3–32



Normal Brake Valve
Figure 3–33



Brake Assembly
Figure 3–34

brake pressure is increased, the spool is forced back upward up to the neutral position where brake pressure is balanced with spring force. Thus, the normal brake valve functions to produce brake pressure proportional to pedal force.

(4) Brake Assembly

The brake is a single-plate, self-adjusting brake of such a design that three hydraulically operated pistons press a single, iron-plate disc which rotates together with the wheel.

When the brake is "ON", the pistons move inwards to press the disc. At this time, the spring contracts and the spring guide comes in contact with the spring seat. If the disc and lining are worn, the piston draws the pin inwards, shifting the spring seat inwards by the total amount of wear;
Even if the brake is released to "OFF", the pin remains at the position.

Thus, the same brake clearance is always maintained.

Wear limit of disc

a. The thinnest portion of the disc should not be less than 0.75 in (19 mm).

b. The disc weight should not be less than 29.5 lb (13.4 kg).

Wear limit of lining

a. The clearance between the disc and the shoulder of the housing on the piston side should not be more than 0.625 in(15.9 mm) with the brake "ON".

b. The thickness of the lining from its shoulder should not be less than 0.125 in (3.2 mm).

(5) Adjustment of Brake System

A. Control System Stopper

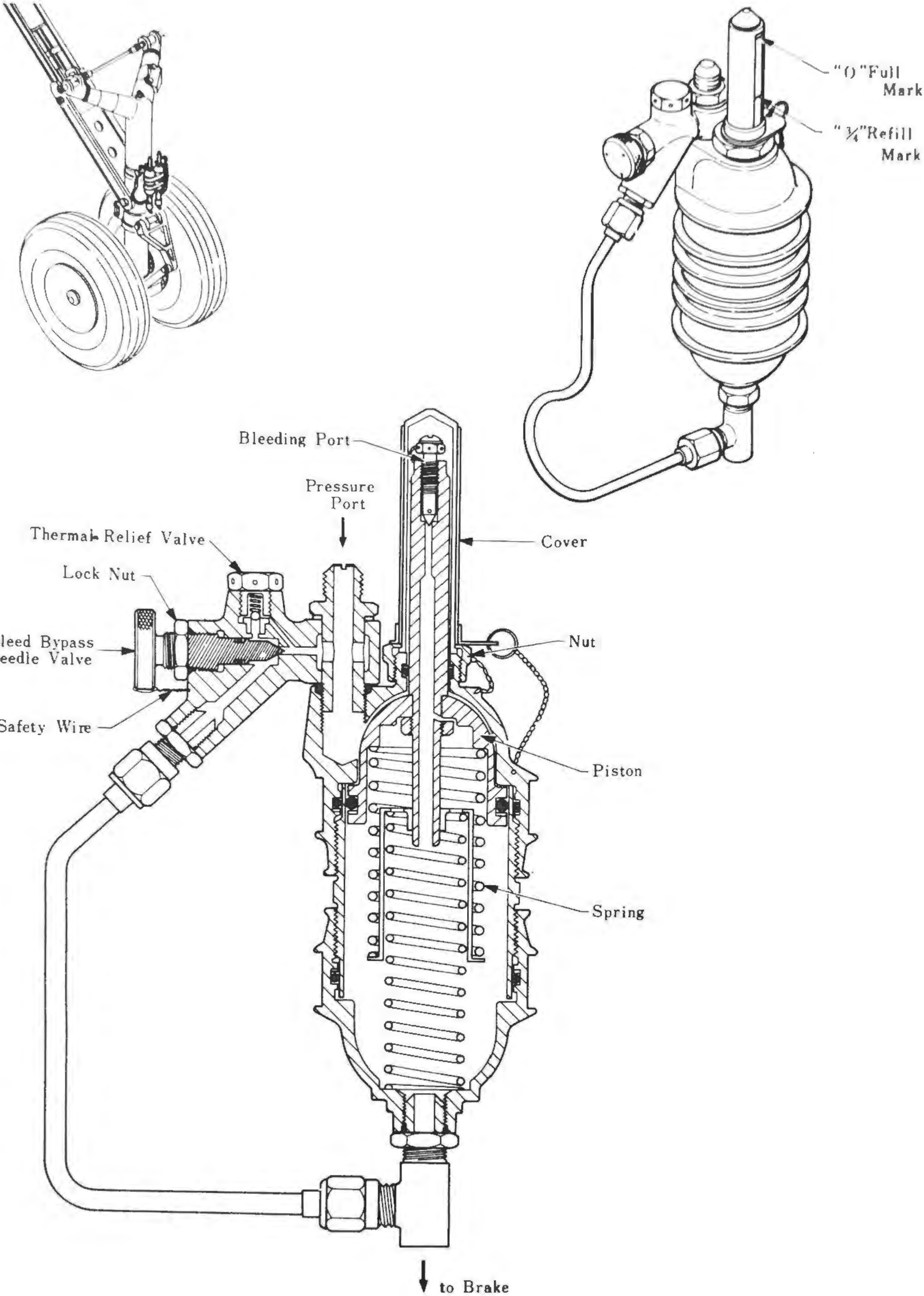
(A) Pedal Stopper (protects system)

(B) Control Valve Stopper (adjusts hydraulic pressure)

a. Brake OFF Position
b. Brake ON Position

B. Adjustment (Fig. 3-36)

(A) Adjust the length of the rods using the rig pins.



Brake Lockout Cylinder
Figure 3–35

(B) Adjust cable tension to 49.7 ± 4.4 lb at 20°C (Cable tension varies by ± 0.72 lb per 1°C)

(C) Adjust the length of the rods (3) and (4) so that rig pin (2) and the valve lever may come in proper contact with the brake-off stop bolt.

(D) Adjustment of Brake Pedal Stopper

a. Adjust the pedal stopper so that, when the pedal is depressed fully, the control valve lever comes in contact with the brake-on stopper.

b. Release the pedal, tighten the stop bolt, turning it two more turns and secure it.

(6) Function Test

Maintain hydraulic pressure at 3,000 psi and make certain the following functions:

A. The brake pressure should be proportionally related to the pedal depressing force.

(A) When the pedal pressure has reached about 10 lb, brake pressure starts to build up.

(B) When the pedal is depressed fully with about 60 lb depressing force, brake pressure should be built up to 1,200 $^{+100}_{-50}$ psi.

B. Difference in pressures to be applied to the four brake assemblies should be within 100 psi.

C. Parking brake pressure should be about 800 psi.

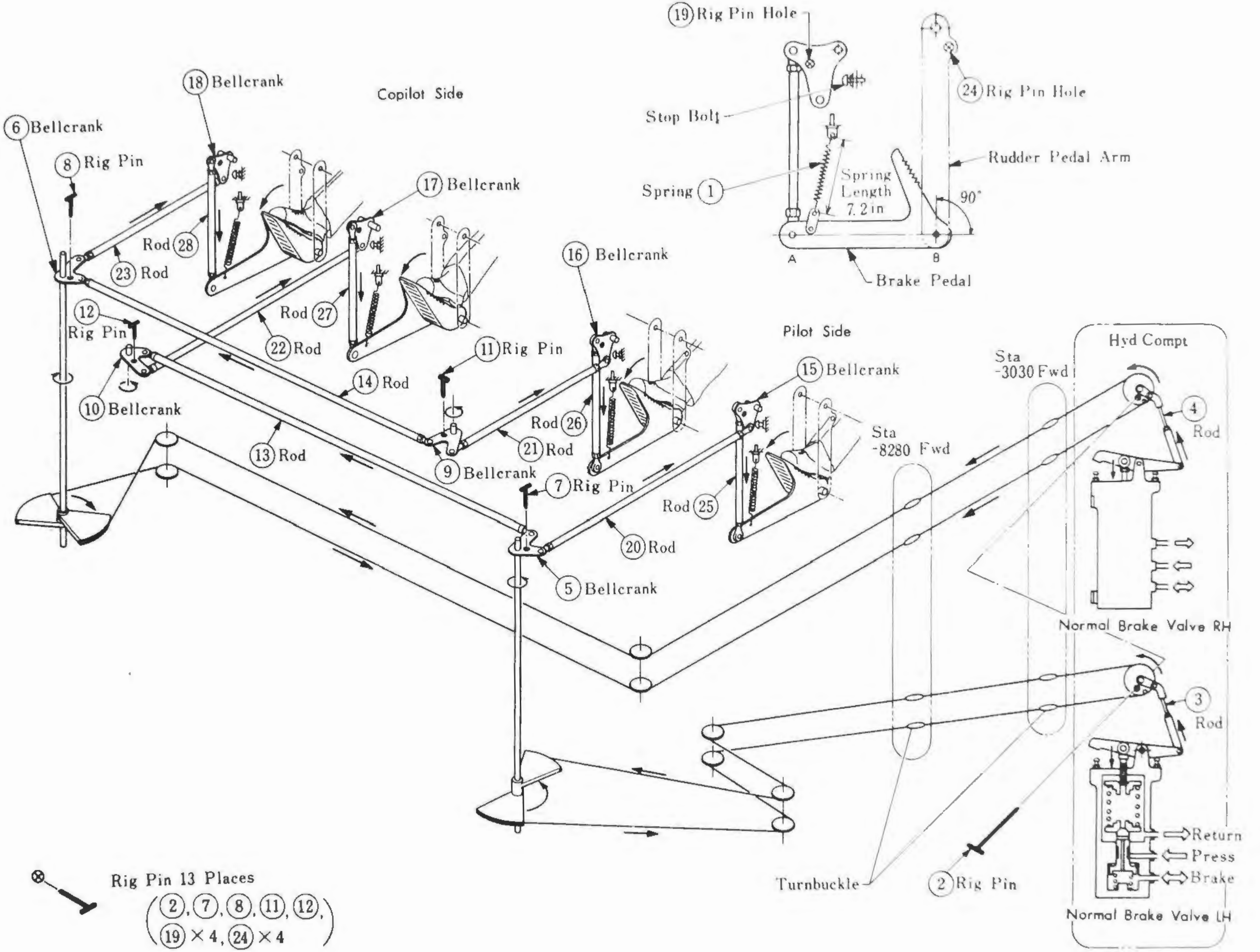
3.5.3 Emergency Brake System

(1) General

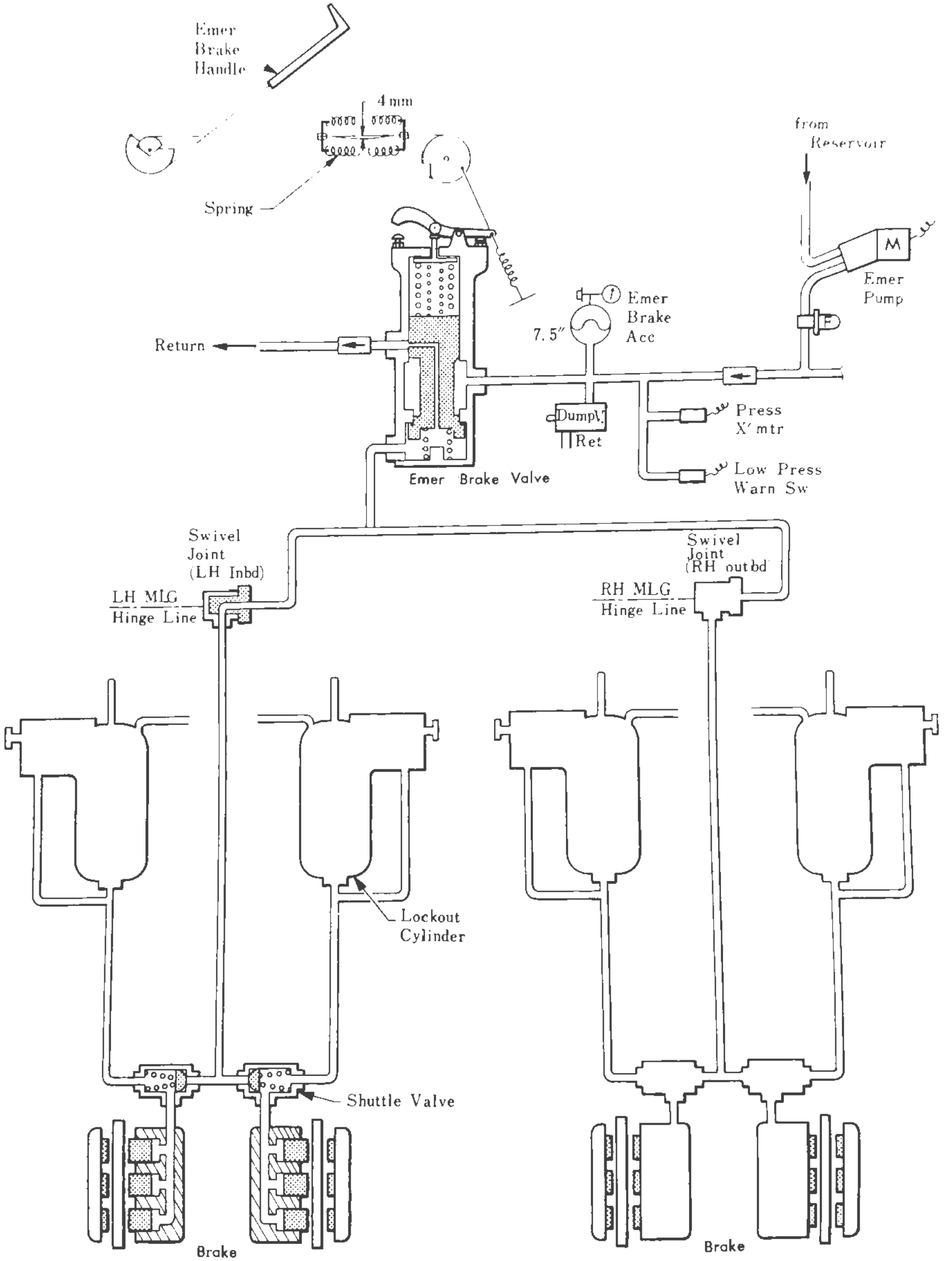
This system is an emergency braking device to be used in case of the normal brake system failure, and is operated by pulling the emergency brake handle located on the pilot side of the center pedestal. This system has its own accumulator and its hydraulic pressure is supplied by a motor driven pump. The maximum system pressure is 2,300 psi approximately two times the normal brake pressure of 1,200 psi.

(2) Operation

A. When the emergency brake handle is pulled, the valve lever is pulled up through cables and rods.



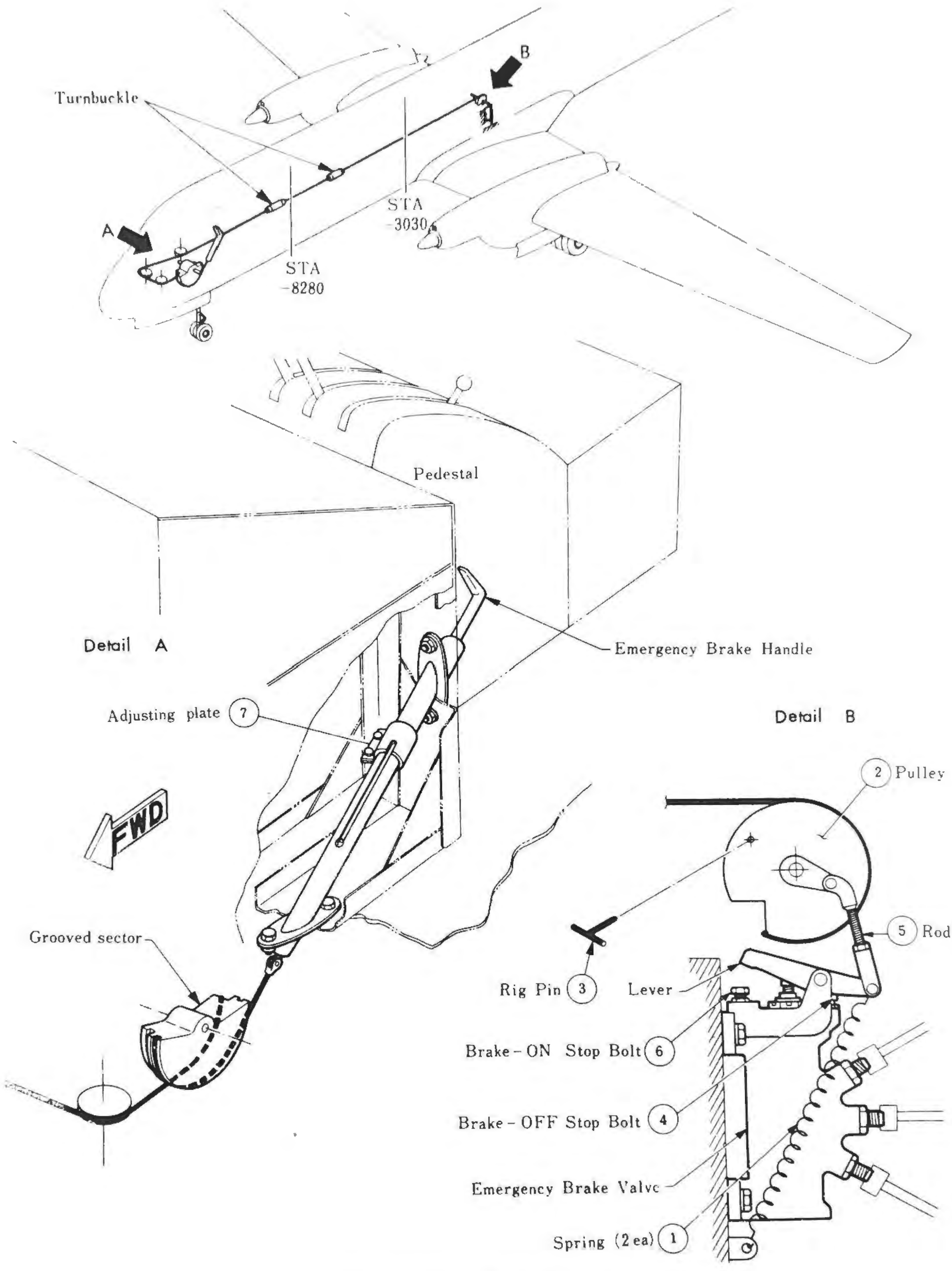
Rigging-Normal Brake System
Figure 3-36



Emergency Brake Hyd Schematic

Figure 3-36A

Reserved



Rigging-Emergency Brake Mechanism
Figure 3-37

B. The brake valve produces the brake pressure in proportion to the force applied to the handle. The pressure produced, passing through the swivel joint, is applied to the shuttle valve.

C. When emergency brake pressure becomes about 6 to 11 psi higher than the normal brake pressure, the shuttle valve attached to the brake assembly feeds pressure oil from the emergency brake valve to the brake assembly and, then, the normal pressure line is closed.

D. Release the handle, and the valve lever is forced back by the returning spring force to the OFF position. Brake pressure goes out to release the brake and, consequently, the shuttle valve returns to its normal position.

(3) Emergency Brake Accumulator (Fig. 3-38)

The emergency brake accumulator is of a spherical, Bendix type (7.5 in). To the tee at the top are connected the emergency brake piping and the piping for the manual damp valve. The accumulator has a capacity of 0.55 gal of hydraulic oil at 3,000 psi hydraulic pressure with air pressure of 1,000 psi.

(4) Adjustment of System (Fig. 3-37)

A. Insert the rig pin (3) in the pulley (2), and adjust the length of the rod (5) so that the valve lever may be in contact with the brake-off stop bolt (4).

B. Tighten the cable turning the turnbuckle, so that there may be some slackness of about 0.158 in (4 mm) on the spring at Fus Sta. -8730.

C. Adjust the position of the adjusting plate (7) so that the emergency brake handle can be pulled on till the valve lever comes in contact with the brake-on stop bolt (6).

(5) Function Test

Maintain the hydraulic pressure at 3,000 psi and make certain the following functions:

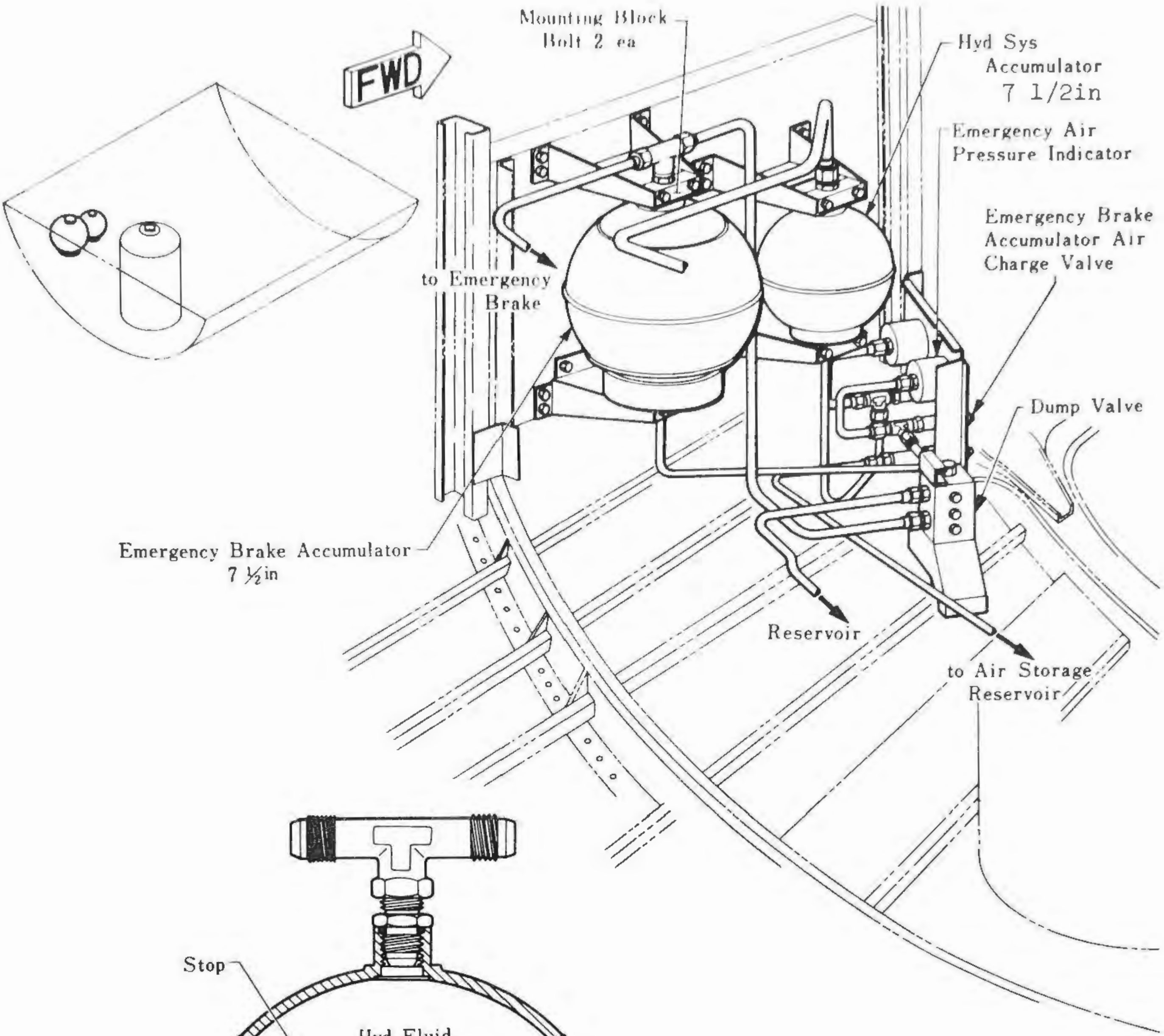
A. When the emergency brake handle is pulled fully, hydraulic pressure in the brake assembly should be 2,300 $^{+0}_{-400}$ psi.

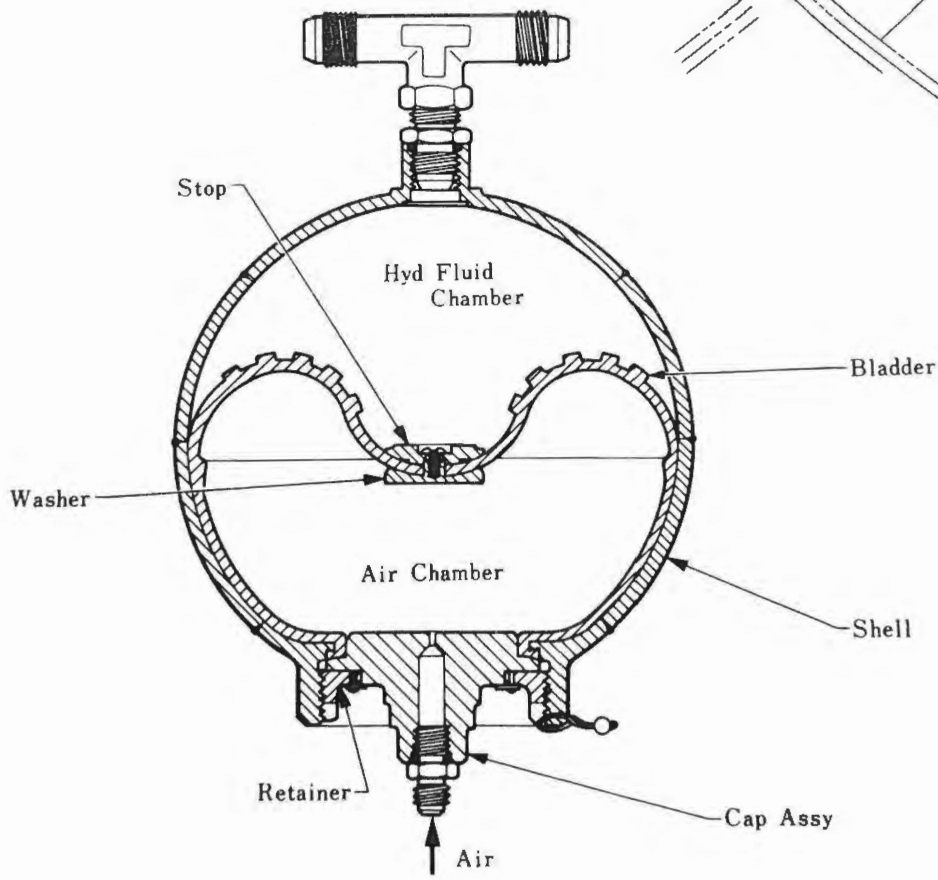
B. When the handle is released and returned, hydraulic pressure in the brake assembly goes out.

3.5.4 Anti-skid System

(1) General

Braking is generally done between the brake disc and lining, however,





Emergency Brake Sys. Accumulator

Figure 3–38

excessive brake application causes friction between the tire and the runway surface, resulting in rapid loss of brake efficiency. (This phenomenon is called "skid")

The anti-skid system functions to minimize this phenomenon, obtaining the maximum brake efficiency.

When the anti-skid switch on the pilot flight instrument panel is set to "ON", this system controls the brake so that the pilot can keep depressing the brake pedal. In case of the system failure, the anti-skid warning light comes on.

This anti-skid system consists of the following elements:

a. Skid Detector

b. Control Box

c. Pressure Modulator

d. Anti-skid Control Valve

(2) Operation (Fig. 3-39)

A. When the anti-skid switch is turned to "ON"

(A) Fail safe relay Z is energized, storing electric power good for 3.5 sec.

(B) Consequently, the secondary power relay X_2 is energized.

(C) The power relay X_1 does not work.

(D) The recovery relay Y is energized, storing electric power good for 0.3 sec.

B. When the tire is about to skid

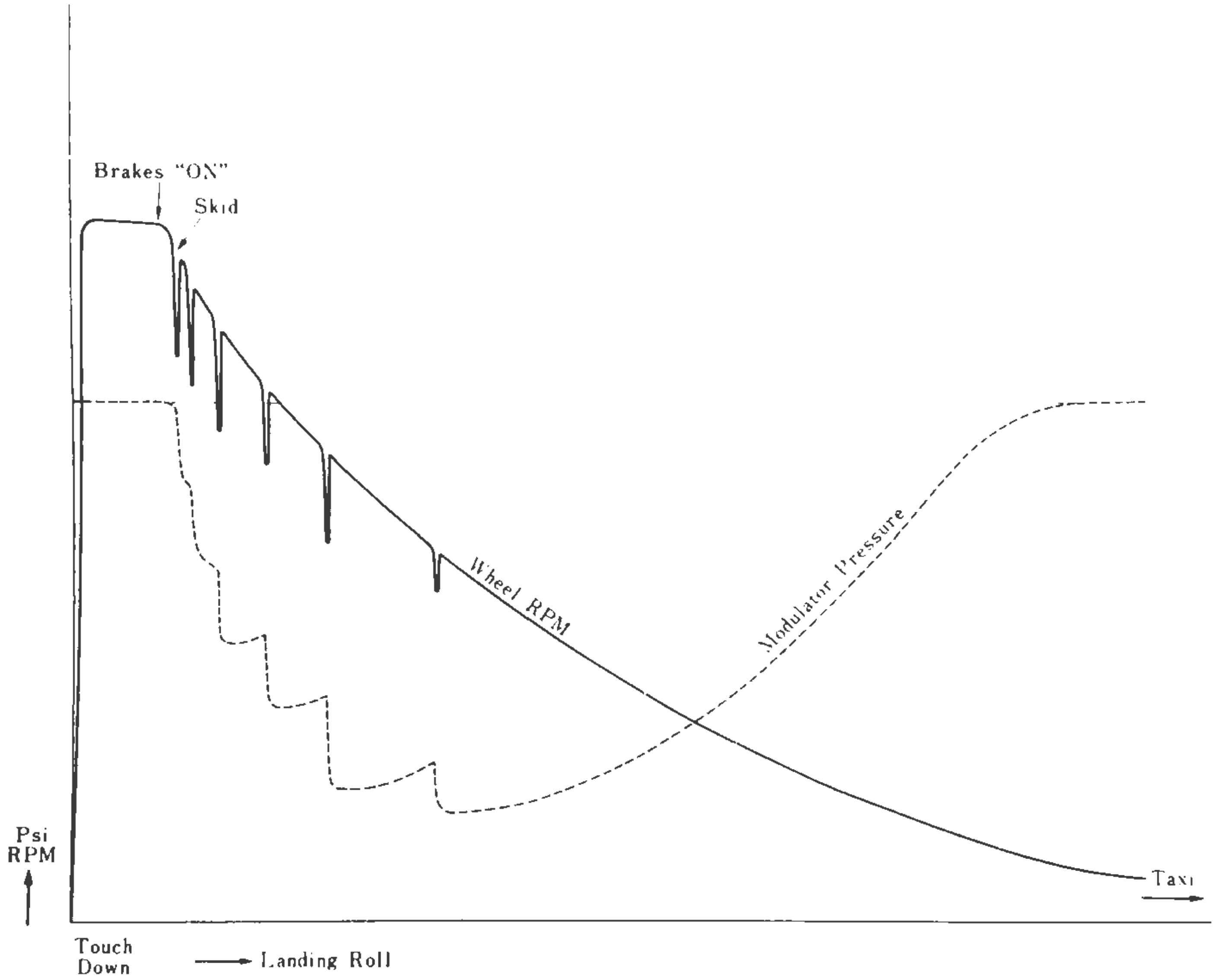
The skid detector generates skid signals.

(A) The relay X_1 is energized, supplying electric power to the anti-skid valve, returning pressure oil -- BRAKE OFF.

(B) Electric power supply to Z and Y is stopped but supply of the stored electric power to Z and Y continues.

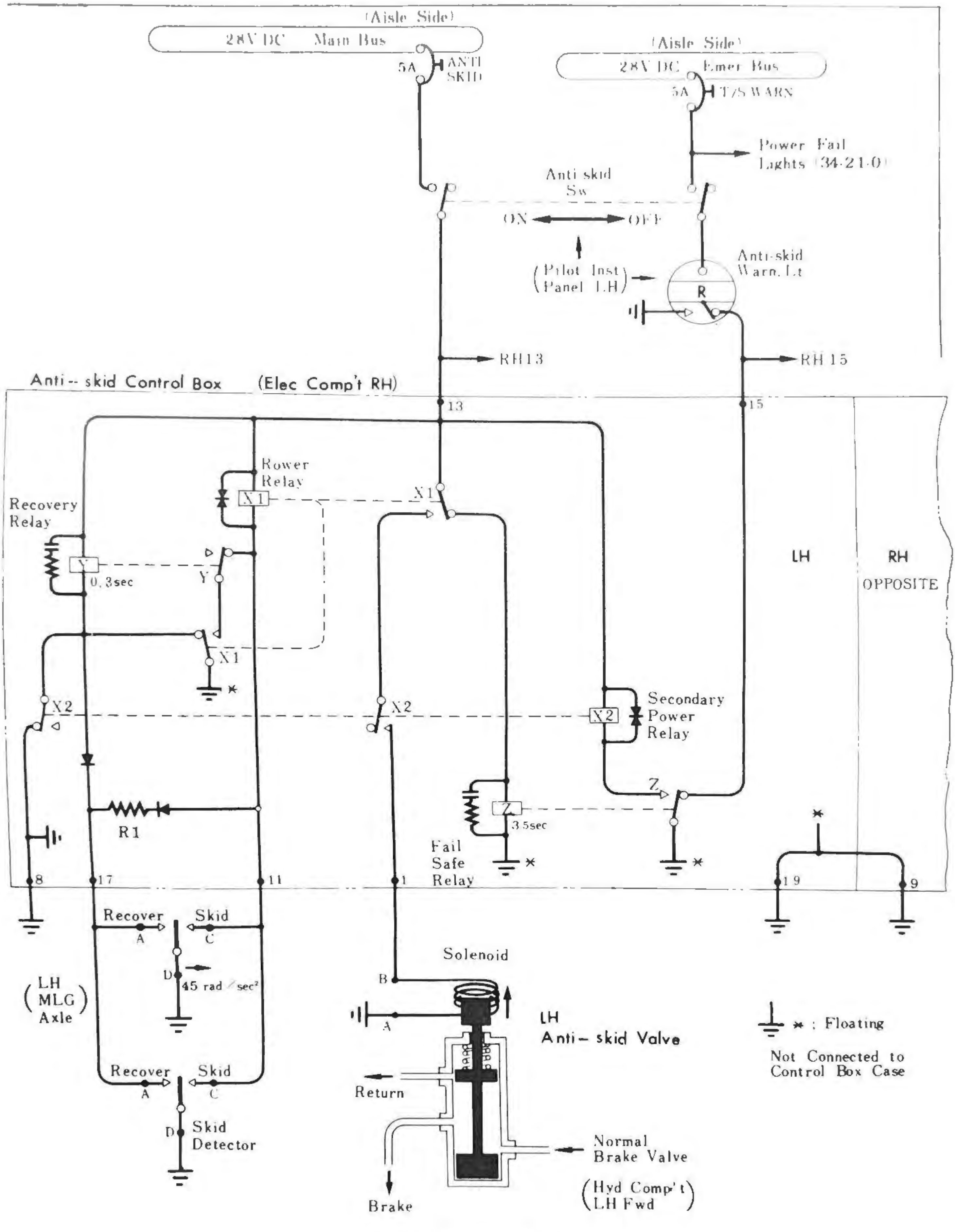
C. If the skid signal stops within 0.3 sec.

(A) X_1 is instantly switched off and the anti-skid valve returns to the BRAKE ON position.



Rough Sketch of Skid and Pressure Drop

Figure 3-39



Anti-skid Electrical System

Figure 3-39A

D. When the skid signal continues for more than 0.3 sec and stops within 3.5 sec.

(A) After the relay Y consumed the stored power, the relay X_1 makes a self-hold circuit.

(B) Thus the X_1 keeps working and the brake is kept at the OFF position even after the skid signal has stopped.

E. If the landing gear speed becomes to normal speed within 3.5 sec.

(A) The acceleration of the gear results in switching on the recover side of the detector.

(B) The relay Y is energized and breaks the self-hold circuit of the X_1.

(C) But the X_1 can not be switched off because the current which passes through R_1 is weak.

(D) When acceleration of the gear has stopped and the recovery contact is switched off, the contact of the X_1 is also switched off setting the brake to the ON position.

F. If the skid signal does not stop even after 3.5 sec.

(A) The relay Z consumes electric power, so the relay X_2 returns to zero, cutting the electric power supply to the anti-skid valve. (Brake ON)

(B) At the same time, the anti-skid warning light comes on.

(3) Skid Detector

The skid detector installed on the main gear is of an inertia switch type. If the wheel is decelerated at a rate of angular velocity over 45 rad/sec^2, this detector generates skid signal; and generates recovery signal when the wheel speed is increased suddenly.

(4) Anti-skid Control Box

This box is installed on the right-hand wall of the electric compartment.
The anti-skid control valve is controlled according to the signal and its duration from the detector.

(5) Anti-skid valve

This valve is installed on the left front corner of the hydraulic compartment under the normal brake valve. This valve is a solenoid valve, and brake pressure line comes to this valve passing through the normal brake valve. When this valve is energized from the

control box, the port leading to the brake valve is closed and pressure oil goes out through the return line.

(6) Anti-skid Modulator

Brake pressure line goes to the brake valve passing through this modulator.
This modulator consists of cylindrical accumulator and orifice.
When the skid signal is generated, pressure oil stored in this modulator is consumed. Replenishment of pressure oil from pressure source is not enough due to the function of the orifice, so the amount of pressure oil consumed by the system always exceeds the amount of pressure oil replenished. Thus, pressure in the modulator drops, decreasing the brake pressure until skidding is stopped.
The filling air pressure of this modulator should be 250 ± 50 psi.

3.5.5 Wheel and Tire

(1) General

A. Wheel

(A) Magnesium alloy casting

(B) Dividable at the center into two, joined together with bolts. Between the two halves, the seal is installed.

(C) Provided with the taper roller bearings, two each.

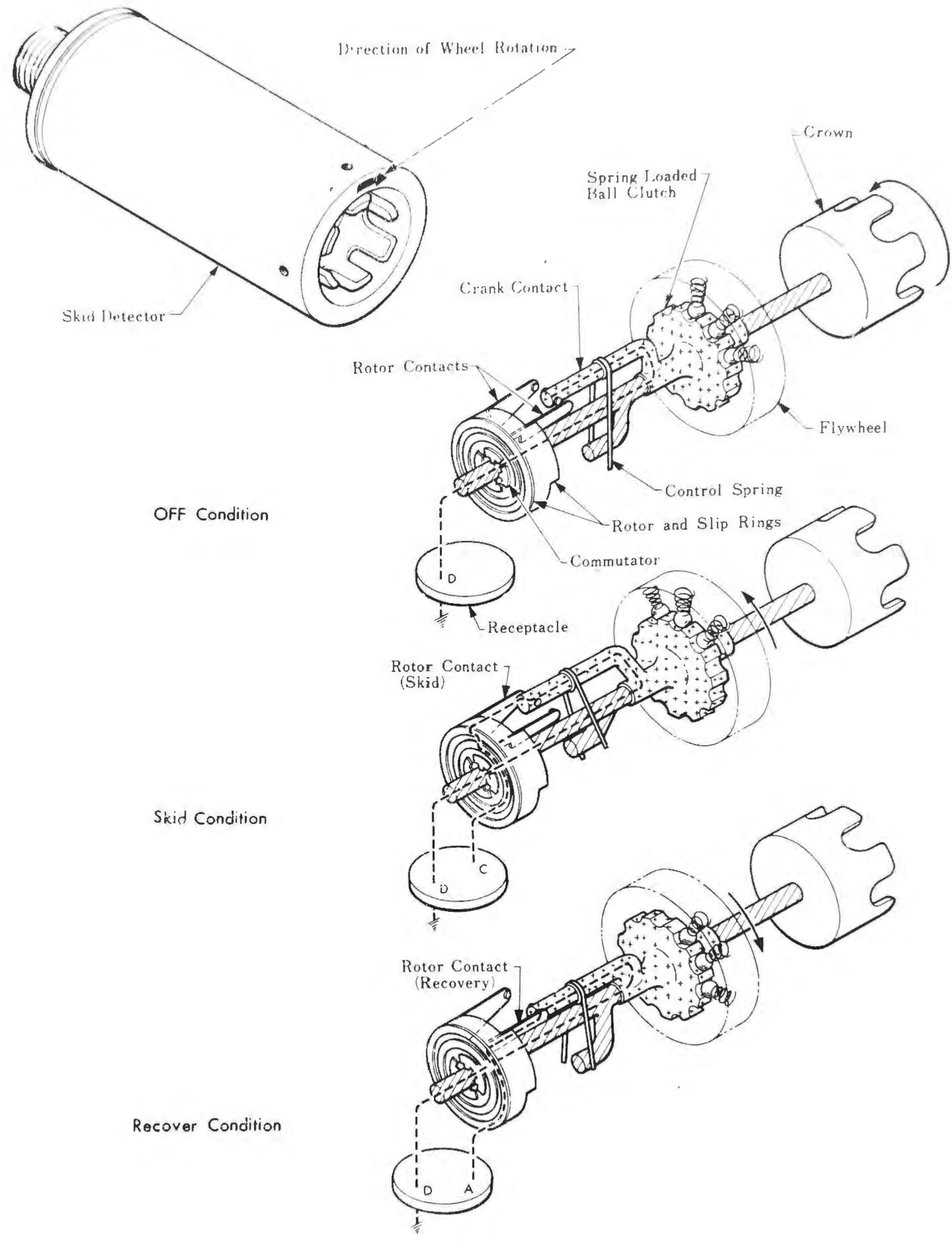
(D) No brake is installed on the nose gear.
The wheels are connected by the co-rotating shaft in the axle.

B. Tire

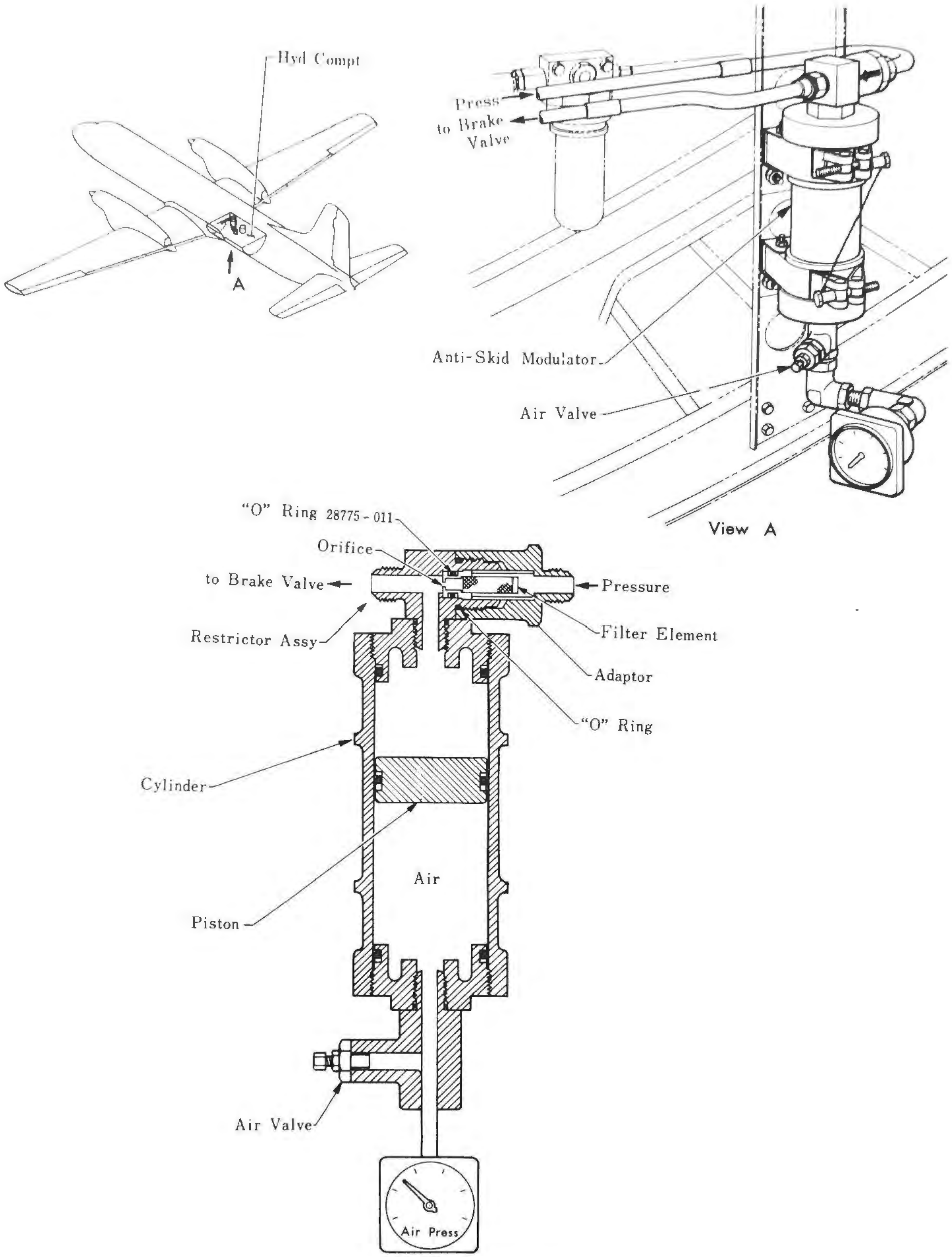
(A) Low pressure tubeless tire

(B) Type, size, etc are shown below:

	Nose Gear	Main Gear
Size	24 X 7.7	12.50 - 16
Play Rating	10	12
Type	VII	III
Beed Bandle	2 X 28	2 X 48
Pressure	50 psi	75 psi



Skid Detector
Figure 3—40



Anti-Skid Modvlator
Figure 3–41

3.6 Steering System

3.6.1 General

Steering operation can be done by turning the steering handle installed on the left-hand console in the cockpit.

Turn the steering handle, and the valve of the steering unit attached to the nose shock strut is turned through a cable allowing pressure oil to turn the torque link. The lower end of the torque link is connected to the nose gear inner cylinder, therefore, the inner cylinder is turned, steering the nose gear.

The proportion of the handle turning angle to steering angle is four to one (4 : 1). The maximum steering angle is 50 degrees on either side.

3.6.2 Operation

Hydraulic pressure from the down line of the gear is supplied to the steering unit through the filter.

The steering unit consists of a valve and cylinder; when the steering handle is turned, the valve is moved by the cable allowing pressure oil to flow to the cylinder.

The rack of the piston rotates the collar gear (torque arm rotates) and the nose gear is steered.

(1) Neutral

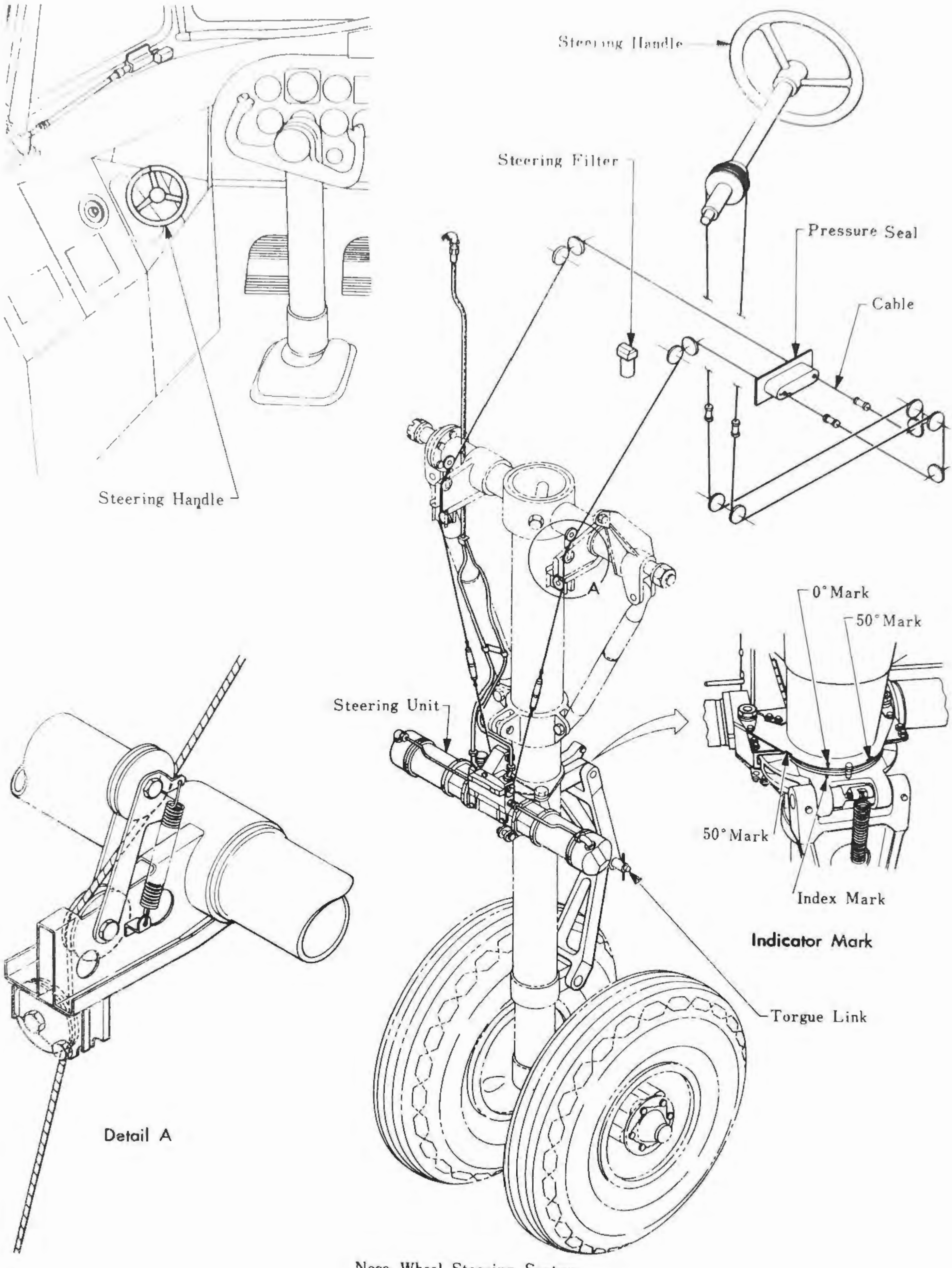
The steering handle is positioned at the center and the arm is vertical. The piston remains at the center, therefore, the torque link is situated behind the shock strut. The wheels face the front. This is the neutral position before starting operation.

(2) When the Handle Is Turned to Right.

Since the piston still remains unmoved, the right cable is pulled and the left one is slackened. As the result, the double pulley is pushed leftwards and the arm is tilted. At this time, the valve spool is also moved leftwards by the yoke. Then, hydraulic pressure oil enters the left side of the cylinder, starting to move the piston towards the right.

(3) When the Piston Moves Rightwards.

The rack turns the collar gear and the wheel gradually steer to the right. The cable end attached to the piston also moves to the right together with the piston pulling the slackened left-hand cable and, on the contrary, slackening the pulled right-hand cable. As the difference in tension between the left and right cables decreases, the yoke returns to the original vertical position.



Nose Wheel Steering System

Figure 3–42

When the nose wheel steers to the right at such an angle as proportional to the handle turning angle, the valve returns to the neutral position and the nose wheel stops at this angle.

3.6.3 Adjustment (Fig. 3-44, 3-45)

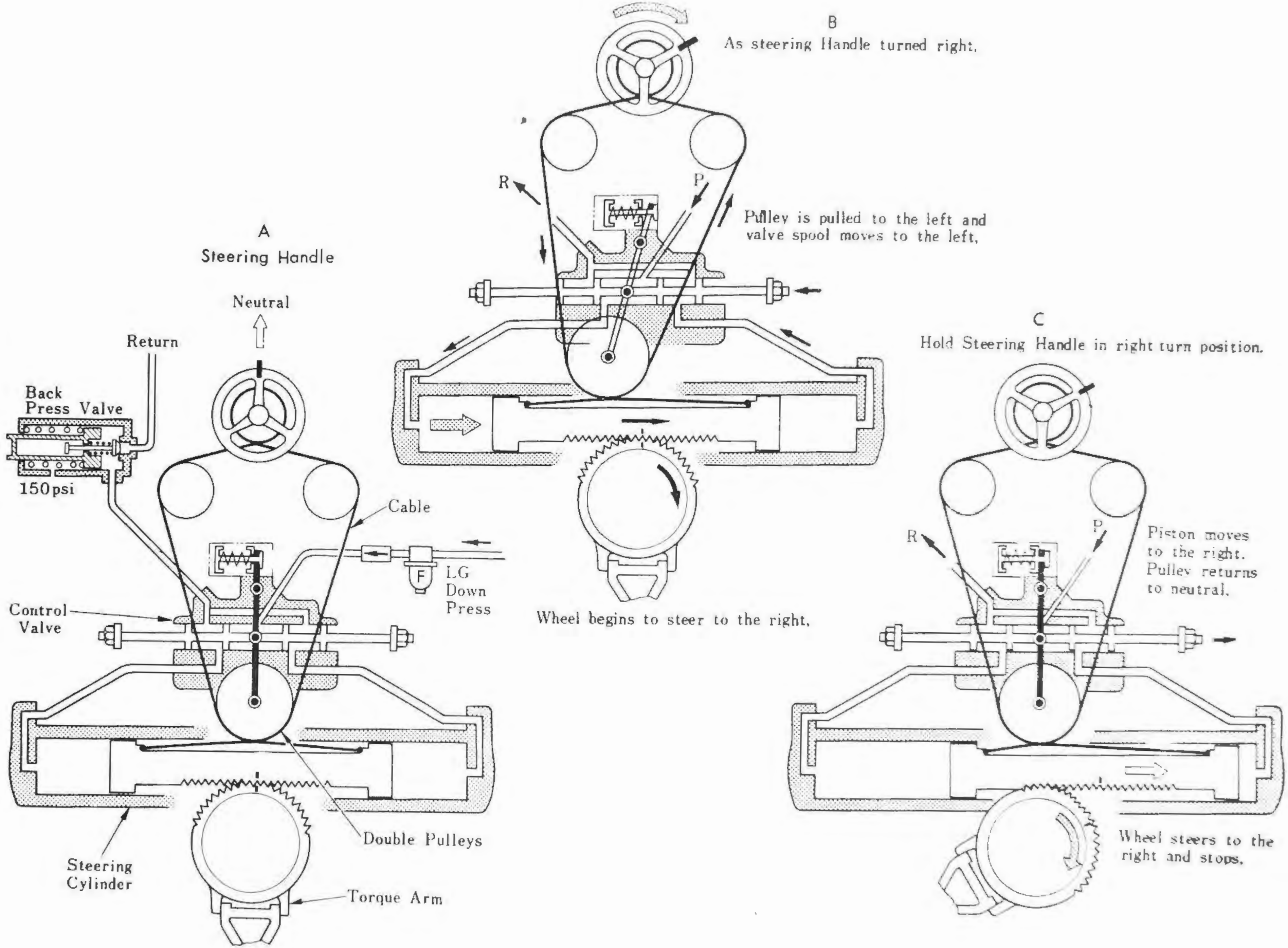
(1) Insert the rig pins (1) and (2), and, turning the turnbuckle, adjust the cable tension to 24.3 ± 2.2 lb at 20°C. (Cable tension varies by ±0.7 lb per 1°C)

(2) Increase hydraulic pressure and, operating the steering handle, make certain that the torque link can be moved smoothly.

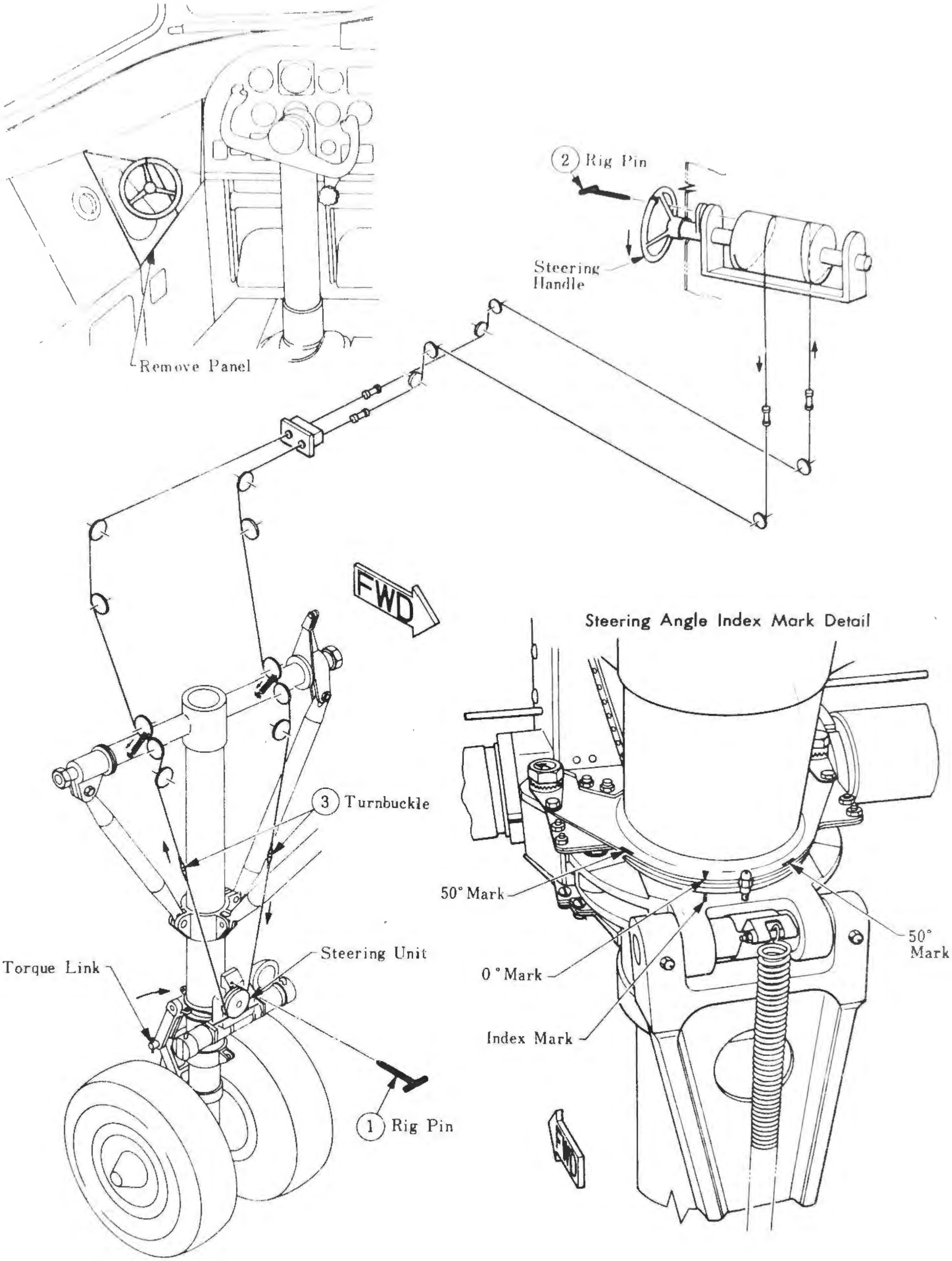
(3) Make certain that, when the handle is set at the neutral position, the torque link also stops at the corresponding position; and, when the handle is turned fully to the left and right, the torque link also turns 50° ± 3° to either side.

(4) Adjust the stop bolt (4) in Fig. 3-45, so that the clearance 1 is within the specified limits.

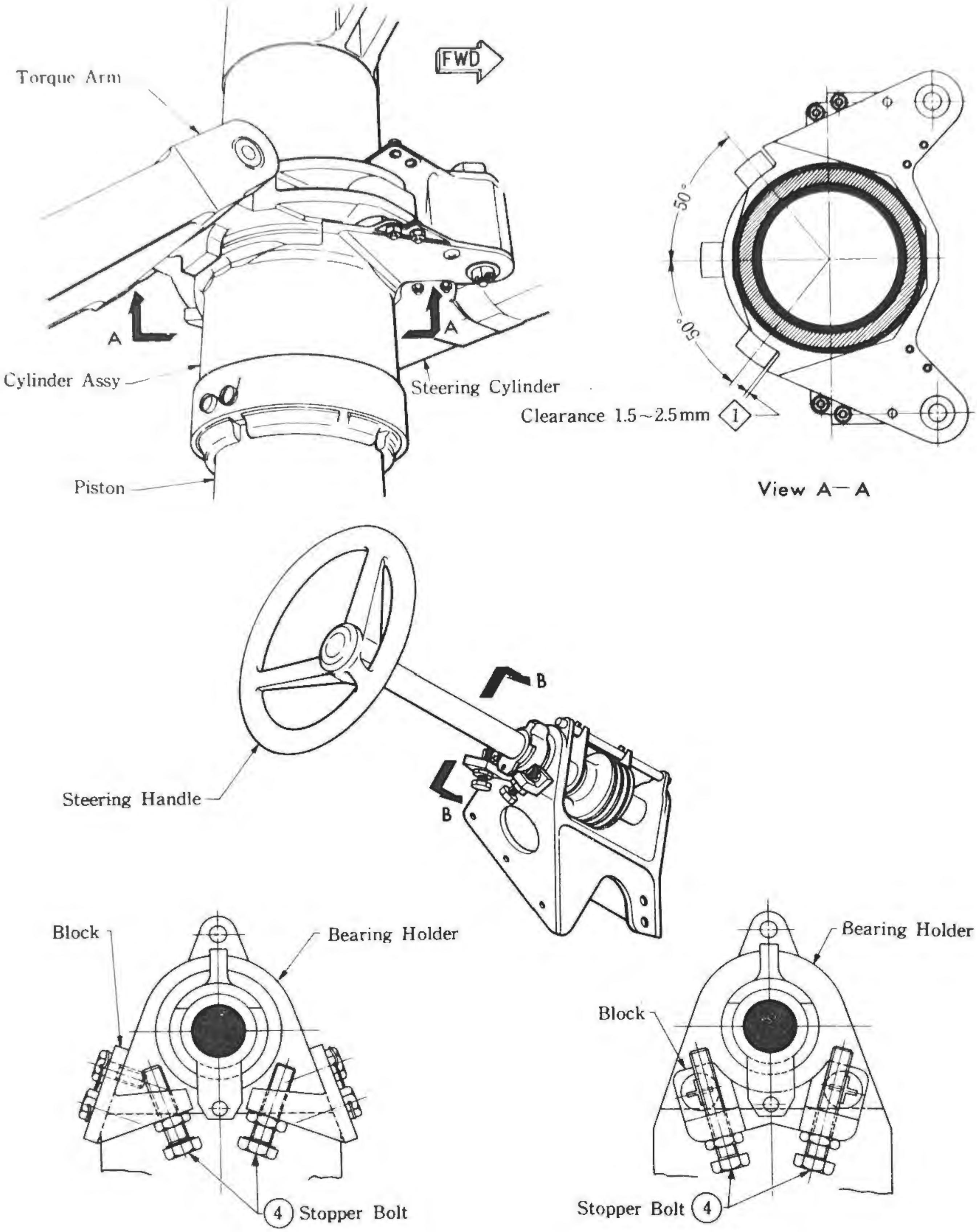
(5) Make certain that, when the torque link is moved with the hydraulic pressure on, the steering handle turns freely, following the movement of the torque link.



Nose Wheel Steering Control System
Figure 3-43



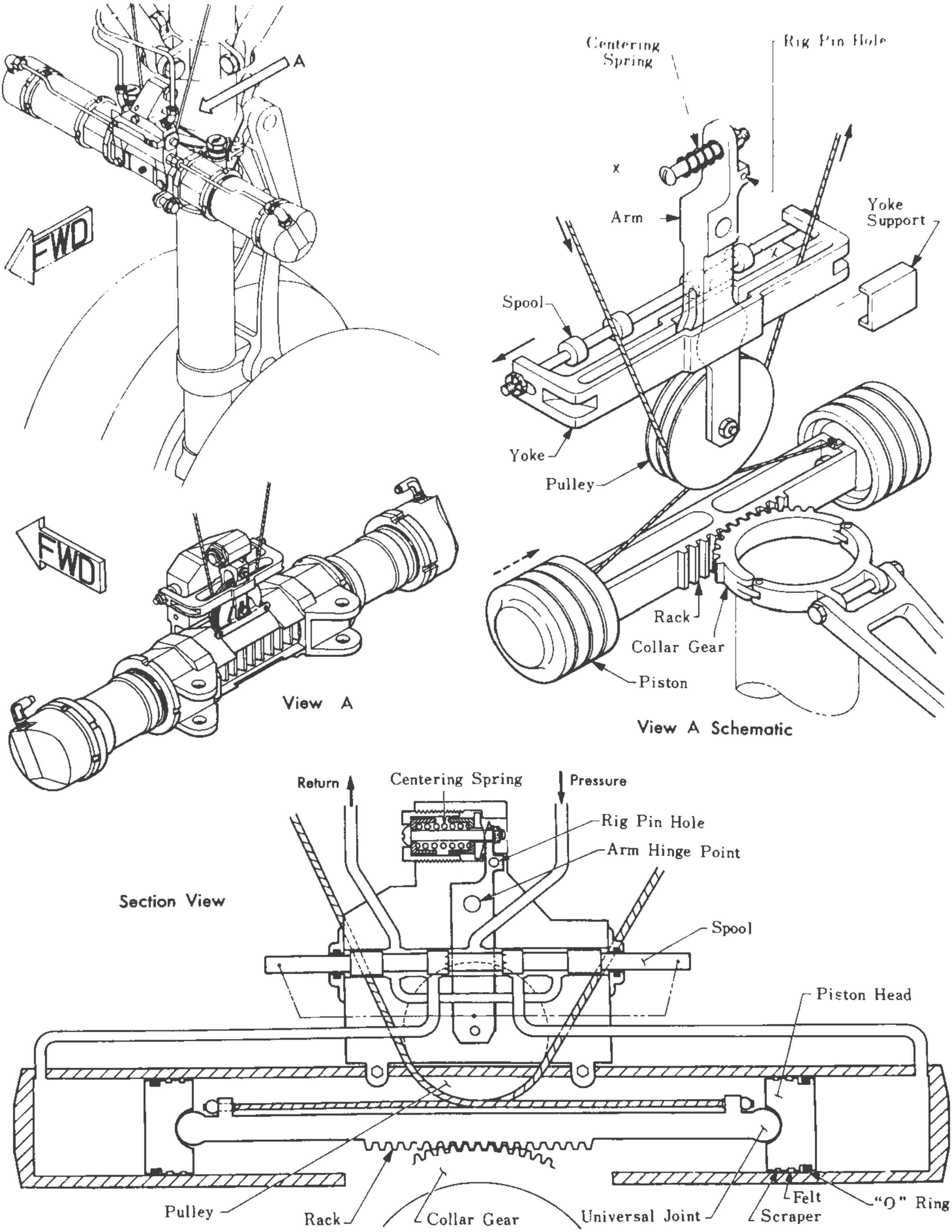
Rigging-Steering System
Figure 3-44



View B－B
Applicable to ～ #2028 which S/B 32-44 has been affected

View B－B
Applicable to #2029～

Rigging-Steering System
Figure 3—45



Nose Wheel Steering Unit

Figure 3–46

3.7 Landing Gear Position Indication and Warning System

This system is for the indication of the lan.ing gear position and warning, and consists of the following three systems:

A. Landing Gear Indication and Warning System

B. Main Gear Down Lock Visual Check System

C. Nose Gear Down Lock Visual Check System

3.7.1 Landing Gear Indication and Warning System

This system consists of the following three sub-systems, all of which operate on electric power from the DC emergency bus.

(1) Landing Gear Position Indicator

The position of the landing gear is indicated by three green lamps and one red lamp. When the three gears are extended and locked at the DOWN LOCK position, the down-lock switch fixed to the top of the lower drag link of each gear is pressed by the down-lock hook and three green lamps come on.

If one gear is not down-locked, the corresponding green lamp does not come on and the red lamp comes on.

When the three gears are retracted and locked at the UP LOCK position, each up-lock switch is pressed by its link mechanism and the circuit is broken, and all four lamps go out.

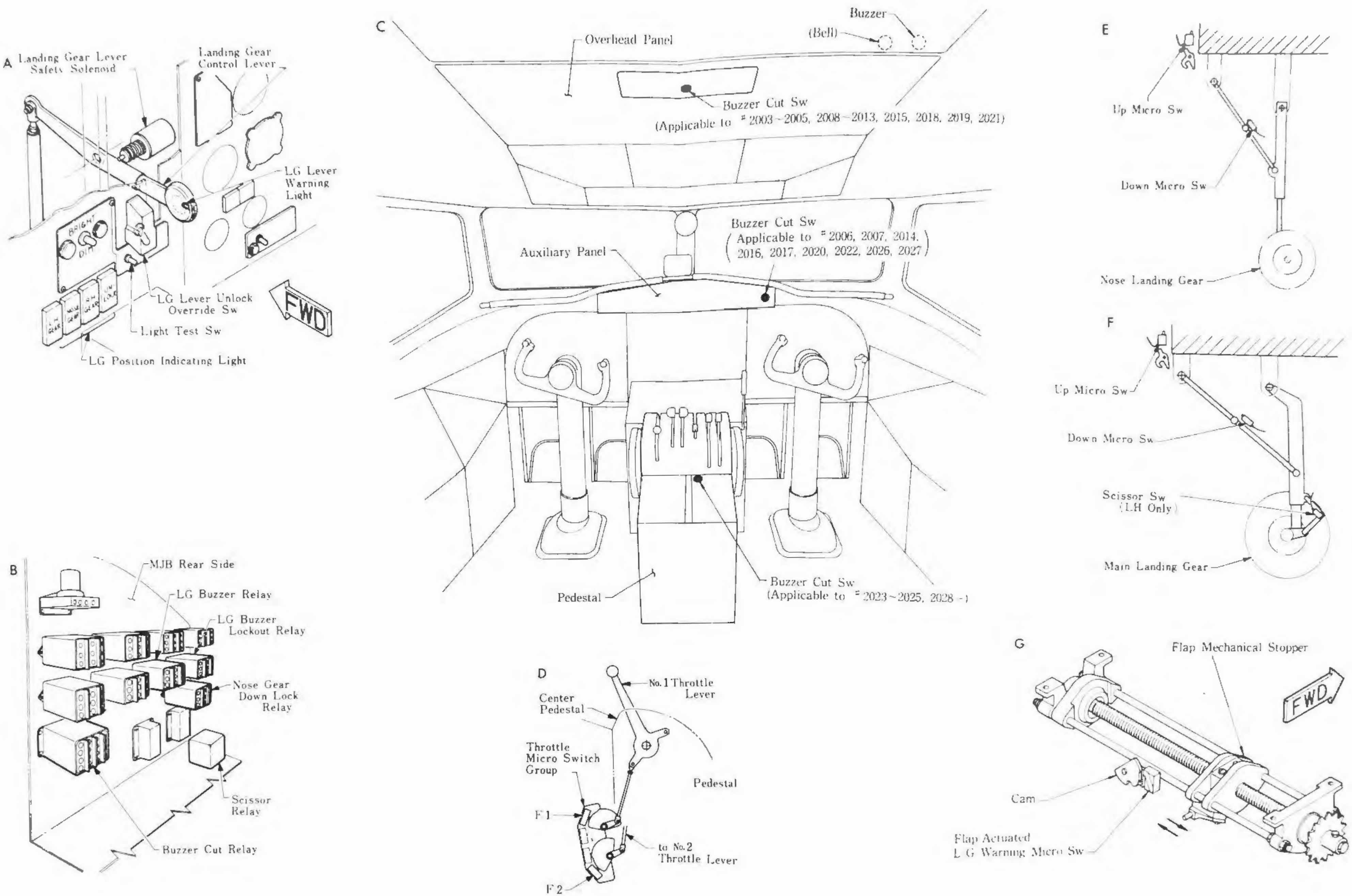
(2) Warning System

A. When one of three gears is not locked at the DOWN LOCK position, if the throttle lever is pulled back beyond the flight idle position, the red lamp on the head of the landing gear lever comes on and also the buzzer on the cockpit ceiling sounds. (the buzzer can be stopped).

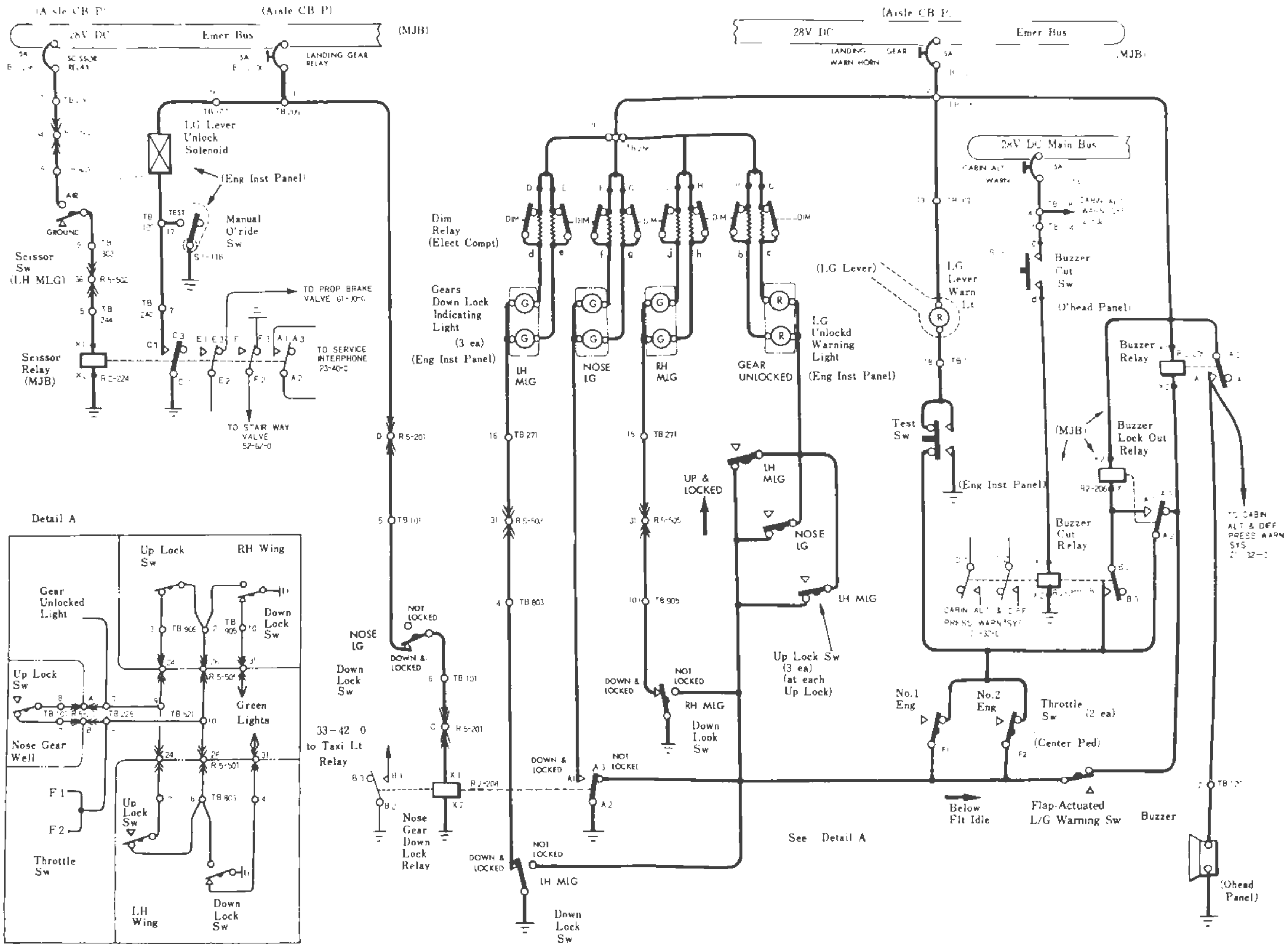
B. Like A above, with one of three gears not down-locked, if the flap is lowered more than 22.5 degrees, the said red lamp comes on and the buzzer sounds. (buzzer can not be stopped)

(3) Landing Gear Control Lever Safety Device

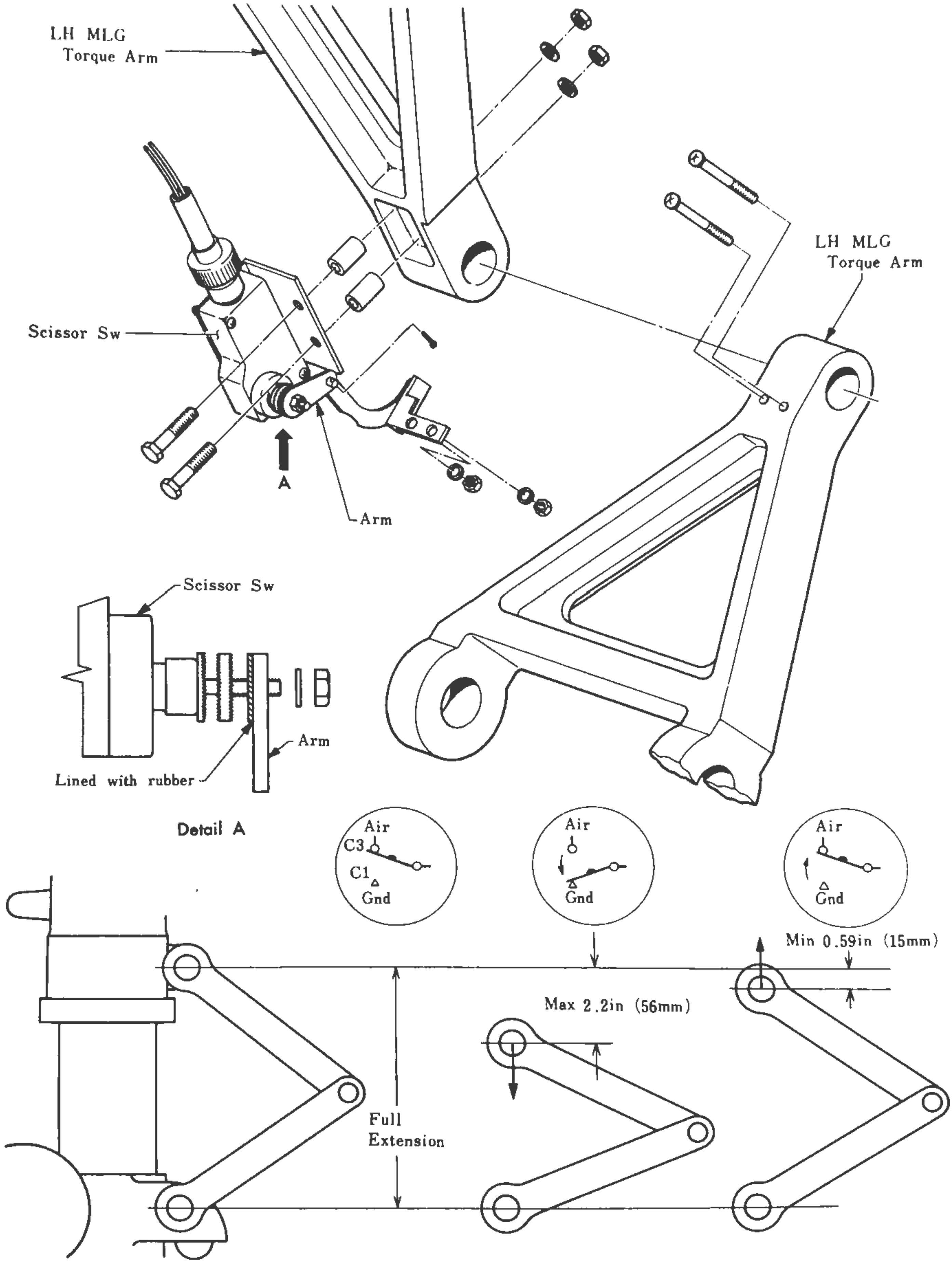
The landing gear control lever is designed to be held by the safety solenoid pin which prevents the lever from being raised beyond the neutral position when the aircraft is on the ground.
When the left main gear becomes clear off the ground and is fully extended, the scissor switch is switched to FLT ON and the solenoid pin is electrically drawn back, moving up the lever can.



Landing Gear Electric & Warning System
Figure 3-47

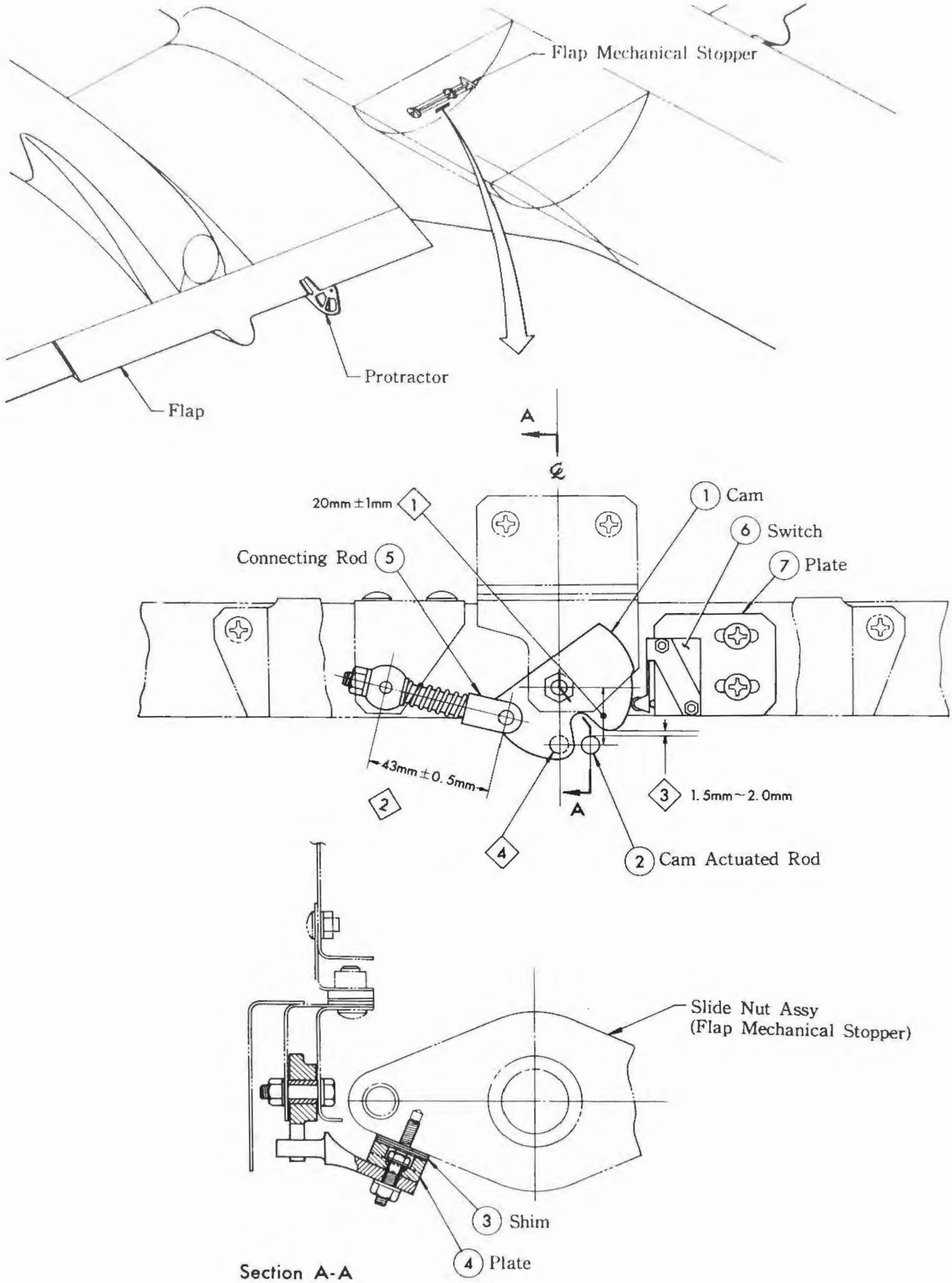


Landing Gear Indicating & Warning Electric System Schematic
Figure 3-48



Scissor Switch (LH MLG Only)

Figure 3-48A



Adjustment Flap Actuating Landing Gear Warning Micro Switch

Figure 3-48B

3.7.2 Main Gear Down Lock Visual Check System

When the electrical landing gear position indication system does not work, the down-locked main gear can be ascertained by visual inspection, through the window at the rear cabin, and the gear position indicator at the lower end of the drag link.

When the gear is locked at the DOWN LOCK position, red fluorescent paint with stripes on the inner cylinder becomes visible through the opening of the outer cylinder. For easier confirmation, a lamp is provided above the indicator.

3.7.3 Nose Gear Down Lock Visual Check System

Open the peep hole on the floor under the center pedestal in the cockpit and the nose gear down-lock can be seen in the mirror through the window on the front wall of the electrical compartment.

The nose gear down-lock mechanism is coated with red fluorescent paint. When the nose gear is locked at the DOWN LOCK position, the red fluorescent coating appears continuous. As this area is dark, a lamp is installed to illuminate the down-lock mechanism.

3.7.4 Adjustment (Fig. 3-48B)

Accomplish this adjustment after the flap and the mechanical stopper have been adjusted.

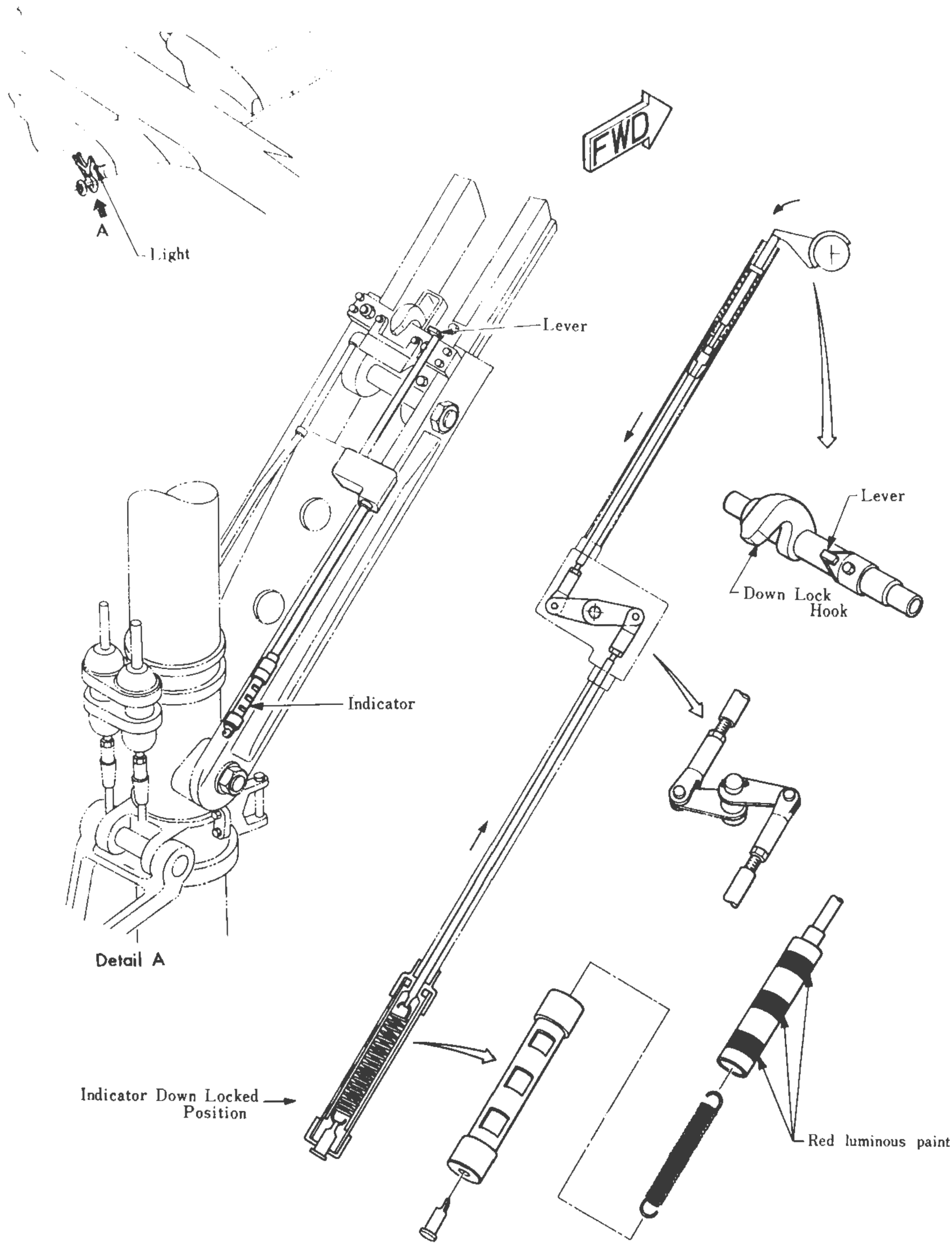
(1) Adjust shims (3) so that the distance ◇1 between the center of rotation of the cam (1) and the center of the cam actuated rod (2) is 20±1mm and install the plate (4).

(2) Install the connecting rod (5) so that the dimension ◇2 is 43±0.5mm. Make sure that the clearance ◇3 is 1.5 to 2.0mm.

(3) With the flap down, measure the flap angle with a protractor and stop it at 22.5°±1°.

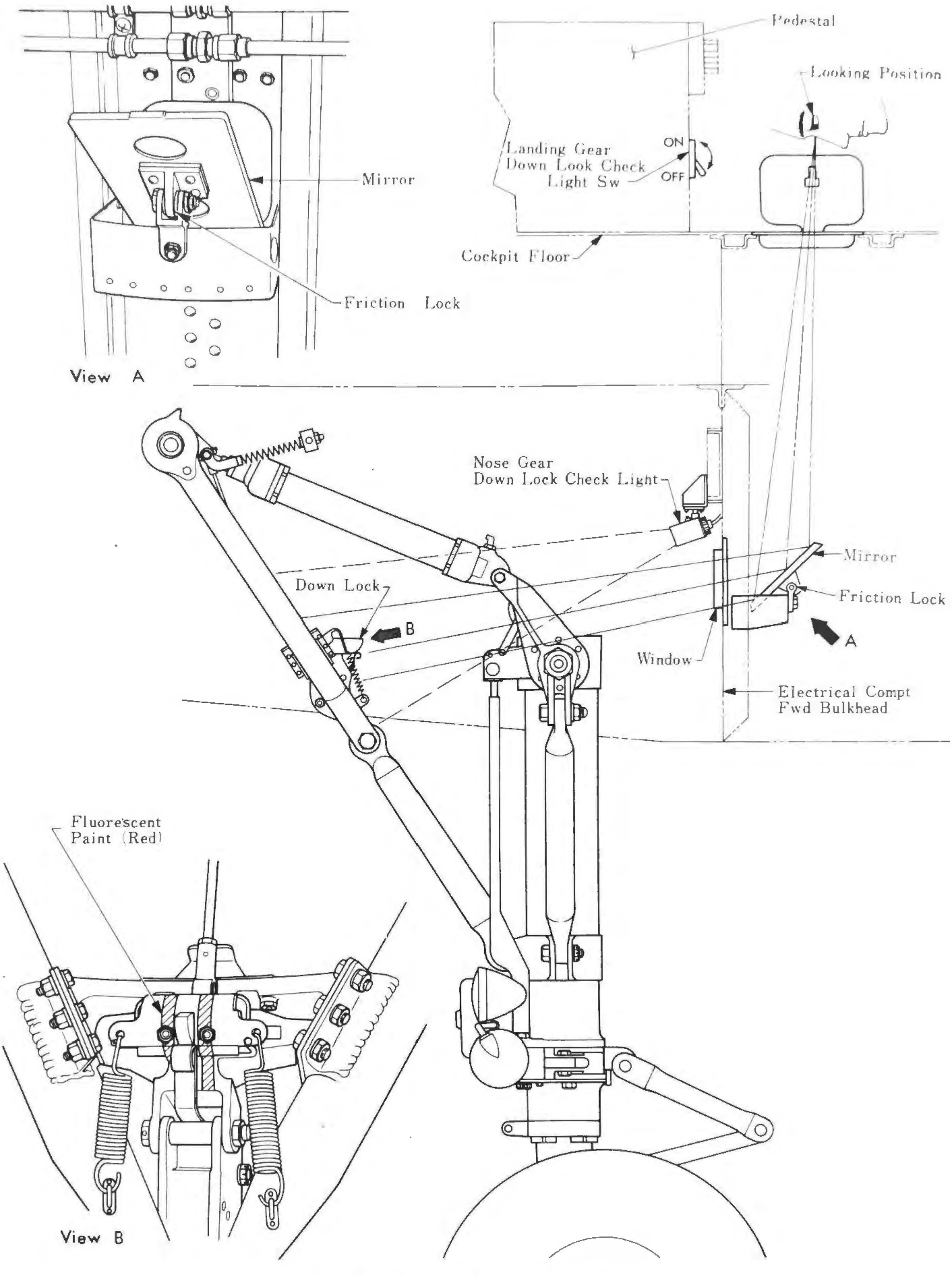
(4) Adjust the serration of the cam actuated rod (2) so that the cam actuated rod (2) rests on the center line ◇4 of the cam (1) under the conditions described in para. (3) and install it.

(5) Adjust the attachment of the plate (7) so that the switch (6) slides smoothly along the contour of the cam and it is actuated roughly at the center of the cam slope.



Main Landing Gear Down Lock Visual Check System

Figure 3–49



Nose Gear Down Lock Visual Ckeck System

Figure 3–50

Chapter 4 POWER PLANT

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Chapter 4 POWER PLANT

4.1 General

The Rolls Royce Dart MK542-10 turboprop engines are installed on the aircraft as complete power units.

This power unit consisting of the engine, propeller, engine mount, piping and wiring is a replacement unit which can be installed in any nacelle.

The propeller can be handled as a replacement unit and the power unit without the propeller is also a replacement unit, while the propellers are also interchangeable.

The engine is mounted on the engine mount at its three forward points while the mount is attached to the nacelle subframe at its four rear points.

Around the engine mounted on the nacelle are installed the cowling, fairing and panels on which are provided the inlet and outlet ports for cooling of the engine and gear box, and accessories mounted on them.

The engine is a gas turbine engine with a 2 stage centrifugal compressor and 3 stage turbine. The engine controlled by the throttle in the cockpit through cables and control rods, drives the propeller, while the exhaust gas at high temperatures from the turbine section flows through the exhaust pipe over the upper surface of the wing and is ejected outboard from the end of the nacelle, developing a little thrust.

The accessories are installed in the upper part of the nacelle. The engine shaft drives the DC generator, AC alternator, hydraulic pump, supercharger etc. through gears and drive shafts at reduced speeds.

Engine Data

Power:	(at I.S.A., Sea Level, Static Condition) RPM	SHP	Thrust	TEHP
Take-off (with W/M)	15,000	2,775	740 lb (336 Kg)	3,060
Take-off (without W/M)	15,000	2,400	660 lb (299 Kg)	2,655
Max. Continuous	15,000	2,400	660 lb (299 Kg)	2,655
Max. Cruise	14,200	1,880	525 lb (238 Kg)	2,080

NOTE: In calculating SHP, 70 HP required to drive the gear box has been taken into account.

$$TEHP = SHP + \frac{\text{Thrust (lb)}}{2.6}$$

Dimensions:

Diameter	Max. (bulkhead) approximately 38 in.
Length	99.5 in.
Weight (dry)	Max. 1,377 lb.

Direction of Rotation:

Propeller	Counter clockwise viewed from the rear.
Engine	Clockwise viewed from the rear.

Propeller:	4 blade, variable pitch Diameter 14.6 ft.
Reduction Ratio:	0.0775 : 1
Compressor:	2 stage, centrifugal Pressure ratio 6.25 : 1 Mass air flow 26.5 lb/sec (I.S.A., 15,000 rpm)
Combustion Chambers:	7 interconnected chambers Ignitors are provided in No. 3 and No. 7.

4.2 Engine

4.2.1 Summary

The engine is a turboprop engine which drives the propeller and the 2 stage compressor with the 3 stage turbine.

This engine consists of the 2 stage centrifugal compressor, 7 combustion chambers and 3 stage axial turbine. The compressor is driven by an outer shaft connected directly to the turbine and the propeller is driven by an inner shaft provided in the outer shaft and connected directly to the turbine, through the reduction gears.

Air taken in from the engine front enters the first stage compressor, pressurized here and, then, enters the second stage compressor, pressurized here again.

Air leaving the compressor enters the combustion chambers in which fuel is injected to burn. The air becomes a suddenly expanded gas flow and passes the turbine.

The most part of the energy contained in this expanded gas is absorbed by the turbine which drives the compressor and the propeller through the reduction gears, generating the propeller thrust. The energy not absorbed by the turbine passes the jet pipe and is ejected rearwards, developing a little amount of available thrust. Water/methanol can be injected to augment the engine power.

4.2.2 Major Components

The engine consists of the following major components:

(1) Air Intake Casing Section

Air Intake Cowling
Air Intake Casing
Reduction Gear
Oil Tank
Bevel Gear Assembly

(2) Compressor Section

A. Front Casing

Rotating Guide Vane
Compressor (Impeller)
Diffuser

B. Main Casing (Interstage Casing)

Inner Casing
Interstage Guide Vanes

C. Outlet Casing

Rotating Guide Vanes
Compressor (Impeller)
Diffuser

(3) Combustion Section

A. Combustion Chamber

Burner

B. Intermediate Casing

(4) Turbine Section

Nozzle Box
Nozzle Guide Vanes
Turbine Assy
Bearing Housing
Heat Shield

(5) Exhaust Section

Exhaust Unit
Jet Pipe Assy
Jet Pipe Shroud

(1) The air intake casing is made of magnesium casting.

On the front of the casing is attached the nose cowling with the electrical deicer system and on the rear side of the cowling is installed a flange which fits the nacelle cowling.

On the L.H. side of the casing are installed the oil filter, water/methanol unit and fuel pump. On the R.H. side are installed the propeller control unit (P.C.U.), feathering pump and starter motor. On the top is located the oil cooler, while on the lower side are installed the engine oil system accessories.

In the casing are located the reduction gear for driving the propeller, oil pump and oil tank.

(2) The compressor front casing is made of magnesium casting.

The main casing (interstage casing) is made of AL ALLOY. The 2 stage centrifugal compressor is retained in this casing. 3 engine mounting fittings are provided on the main casing.

On the lower side is installed the hot air gate valve. On the L.H. lower part and the R.H. upper part are installed the fuel flow control unit (F.C.U.) and the oil pressure transmitter, respectively.

On the outlet casing are installed the breather outlet, accessory drive adapter and compressed air spill outlet. The engine fire wall is also fixed to this casing. The compressed air enters 7 combustion chambers from the compressor outlet casing.

(3) Around the intermediate casing are arranged the combustion chambers which are connected to the turbine nozzle box.

In each combustion chamber are provided a flame tube and burner. The burner injects fuel into the tube, mixing it with air for combustion.

The high energy ignition plugs are provided in No. 3 and No. 7 combustion chambers only to be used for starting. The flame is propagated to the remaining chambers through the interconnectors.

(4) Air burnt and heated in the combustion chambers enters the turbine in the nozzle box.

The turbine wheel consists of discs made of chrome-molibdenum steel and blades.

This 3 stage turbine absorbs the most of the energy contained in the gas flow and converts it into torque to drive the compressor, propeller and accessories.

The gas temperature (turbine gas temperature, T.G.T.) at the turbine exposed high temperatures and pressures is an important parameter for engine control and the temperature is measured by thermo couples located on the second stage nozzle guide vanes (between the first and the second stage turbine wheels).

(5) The gas leaving the turbine is sent to the jet pipe smoothly by means of the exhaust unit provided in the engine nozzle box, reducing the back pressure acting on the turbine.

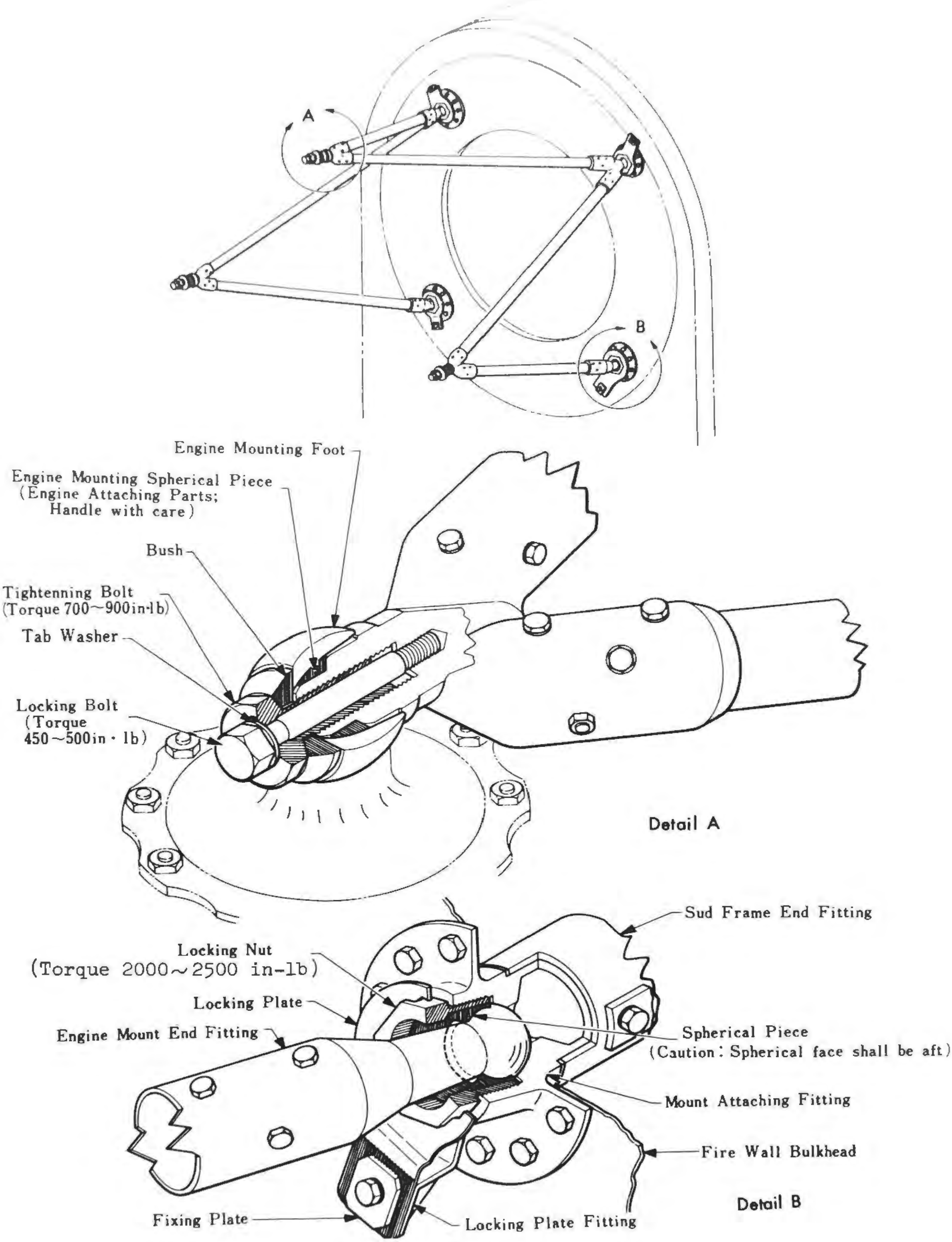
4.3 Engine Mount (Fig. 4-1)

The engine mount is of steel pipe frame construction and its end fittings are all made of forged steel. 3 V shape steel pipe structures are joined together with end fittings and 3 forward points are supported by fittings which are attached on the compressor casing.

The engine mounting feet and engine mounting spherical pieces are joined together at the engine mount end fittings and tightened with hollow tightening bolts screwed in through bushes. A locking bolt with L.H. screw is inserted into the hollow, tightened and locked with a tab washer.

The mount attaching fitting attached to the engine mount rear support B is fixed to the sub-frame and the fire wall with shear bolts.

The 4 engine mount rear supports are fixed to the mount attaching fittings with locking nuts through spherical pieces, that is, ball end halves of the engine mount end fittings. The locking nuts are fixed by the lock plates.



Engine Mounting
Figure 4–1

4.4 Cowling and Fairing

4.4.1 Summary

The nacelle in front of the fire wall is faired with the cowling and the fairing provided in the forward lower part of the fire wall.

When the cowling and the fairing are closed, the overlapping part serves as sealing. The fairing is usually kept installed but it can be removed if necessary. The cowling opens rearwards like flower petals.

NOTE: For the gear box top cover in the rear of the fire wall, exhaust pipe upper cover and gear box side cover, see Chapter 2.

4.4.2 Cowling (See Fig. 4-2, 3, 4, 5 and 6)

The engine cowling consists of 4 panels. The L.H. and R.H. side panels are attached to the L.H. and R.H. nacelle hinges, respectively, the top panel is joined to the L.H. side panel and the bottom panel to the R.H. side panel, through respective hinges.

The cowling made of light alloy, is of double skin construction with partial single skin. The forward ends of the cowling panels are fixed to the engine air intake cowling with screw type fasteners. The top and bottom panels are fastened with latch hooks. The fairing and the side panels are fastened with latch hooks at one location on the L.H. and R.H. sides, respectively.

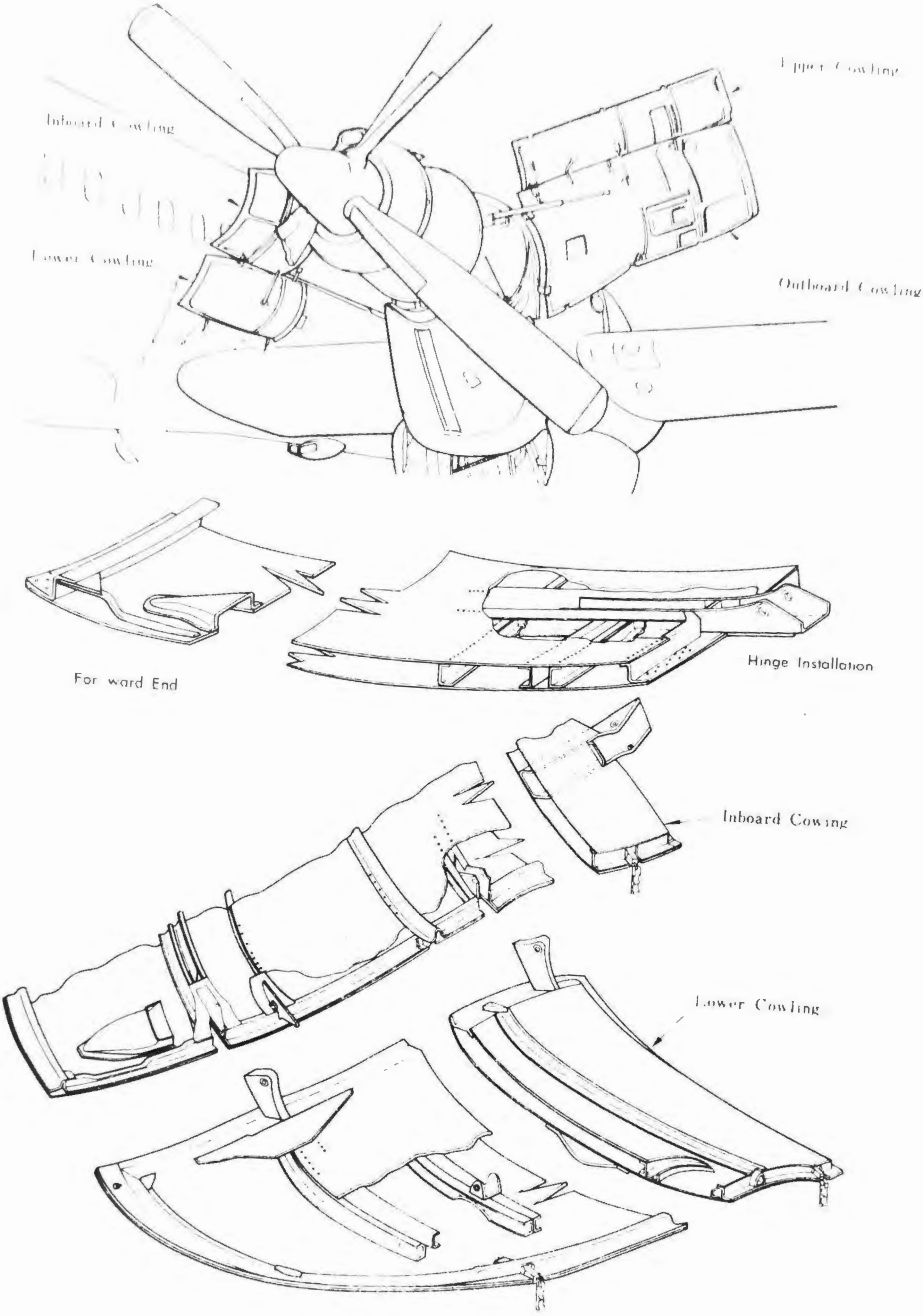
When the cowling is opened, the cowling panels are locked with main cowling supports, 1 ea. The top and bottom panels are locked to the side panels with auxiliary cowling supports, 1 ea.

On each cowling panel is provided a fire wall to separate the compressor section from the hot section when the cowling is closed.

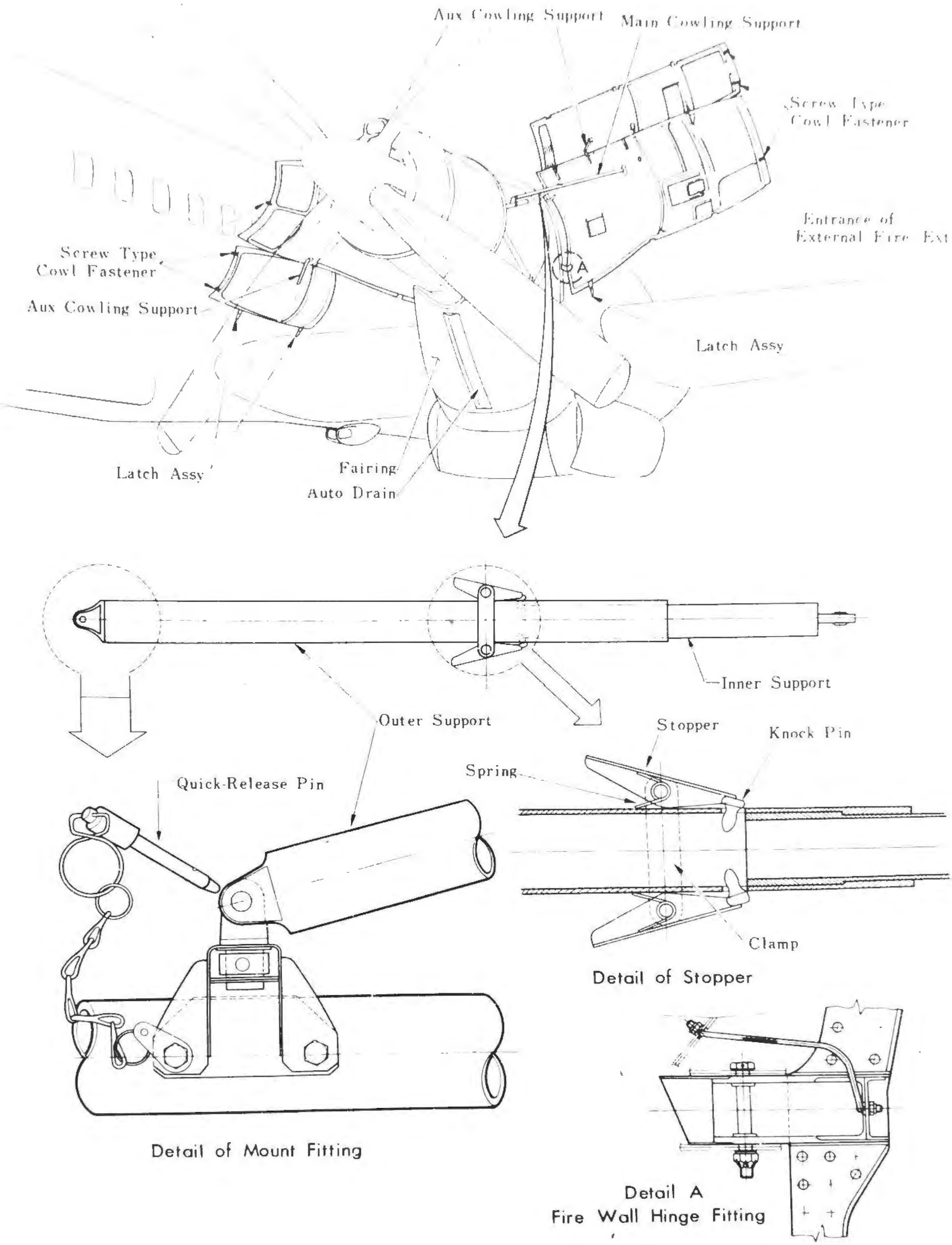
On the L.H. side panel are provided the oil filter cap access panel and fuel filter access panel which are all fastened with hinge latches. On the L.H. side panel are provided fire access doors for Zone I and Zone II through which the hoses of the fire extinguishers on the ground can be inserted for extinguishing fire. As the doors are closed by spring force only, they can be opened by pushing in the hose nozzles. The fire access door for Zone I is provided on the pressure relief door. The pressure relief door is provided on the L.H. side panel. This door relieves the pressure in a space between the engine and the cowling to prevent the high pressure due to the engine casing failure from damaging the aircraft.

The door is fastened to the hinge at its forward part and the rear part is fastened with rivets.

As the inner pressure rises, the rivets are shorn, opening the door outwards. As the pressure decreases, the propeller slip stream closes the door automatically.

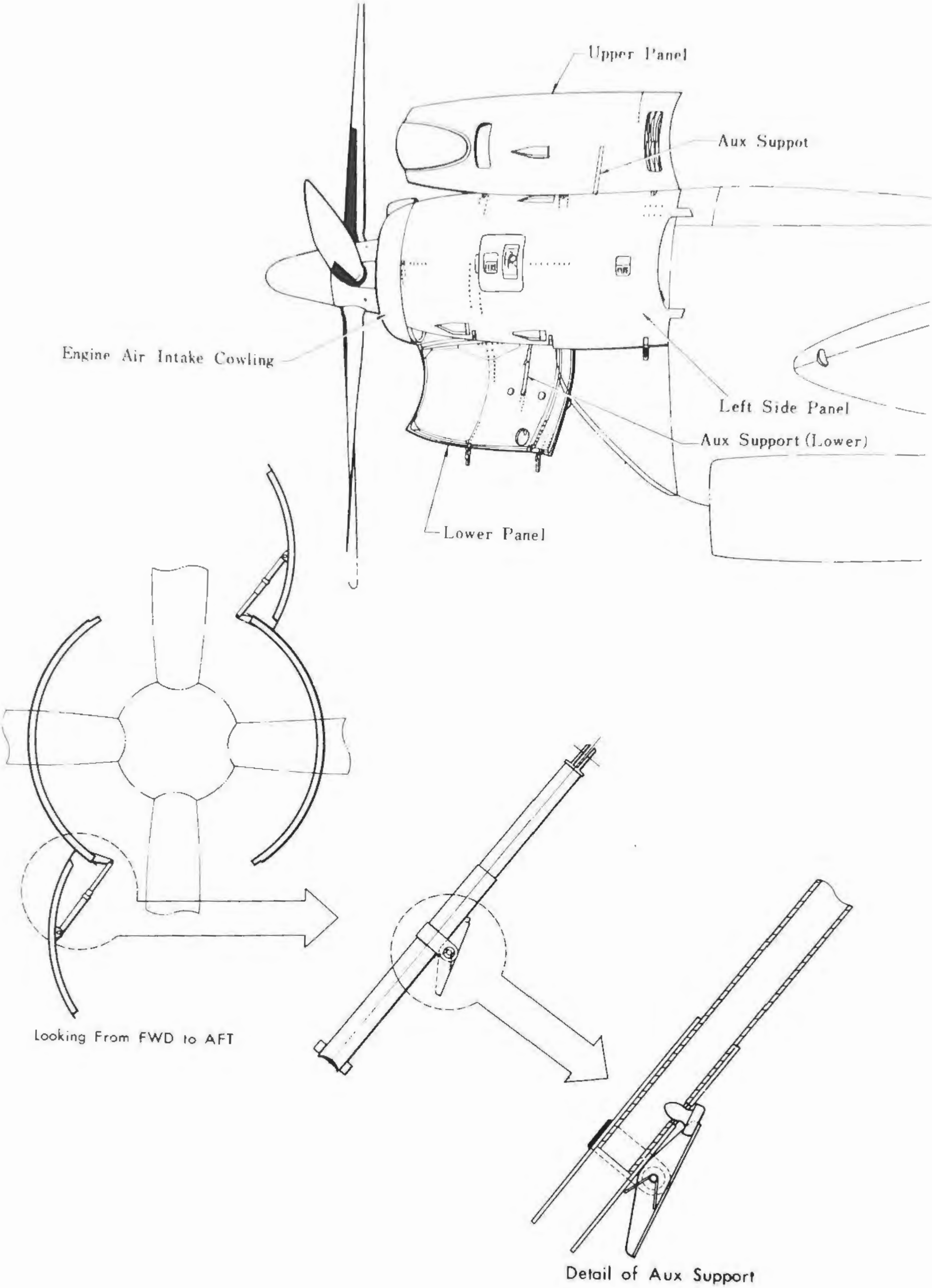


Engine Cowling Structure
Figure 1-2



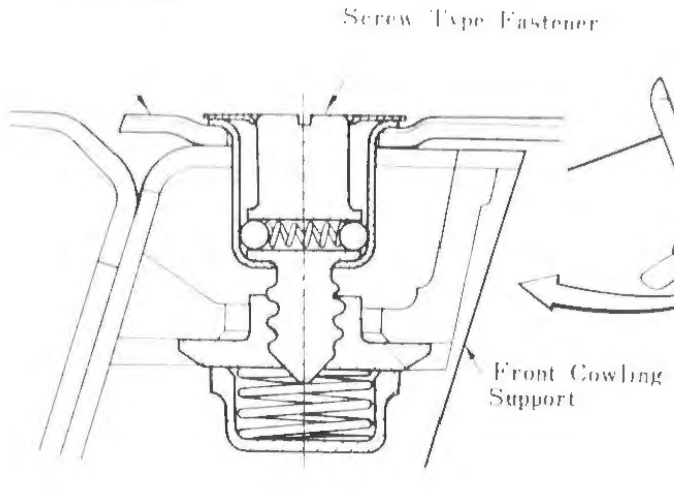
Engine Cowling (Showing Full Open)

Figure 4-3

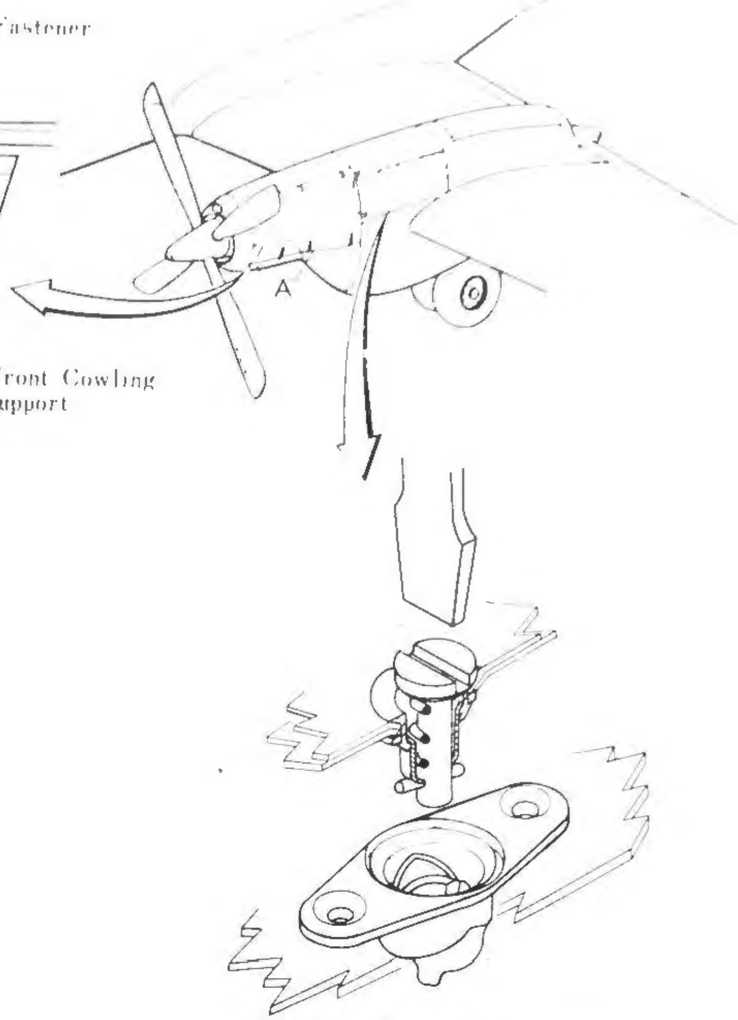


Engine Cowling

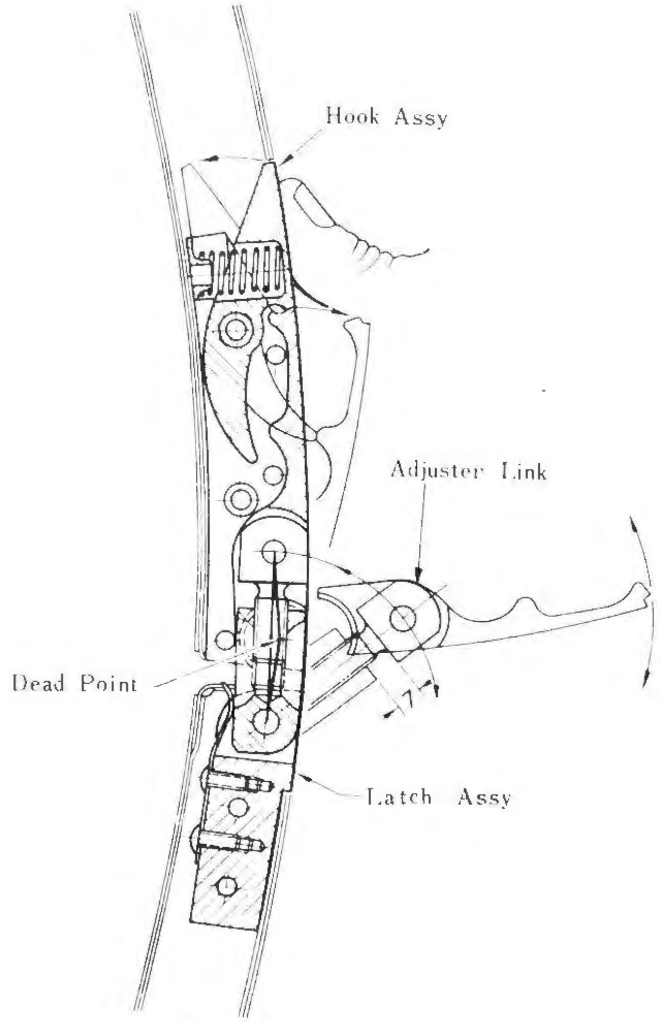
Figure 4–4



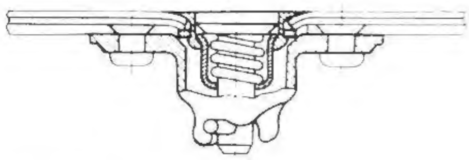
NAPIR Fastener Cross Section View



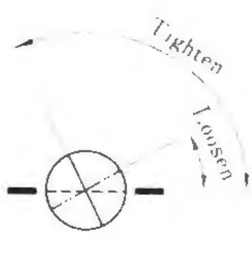
CAMLOC Fastener Cut-Away



Detail A
Latches & Hook Section View

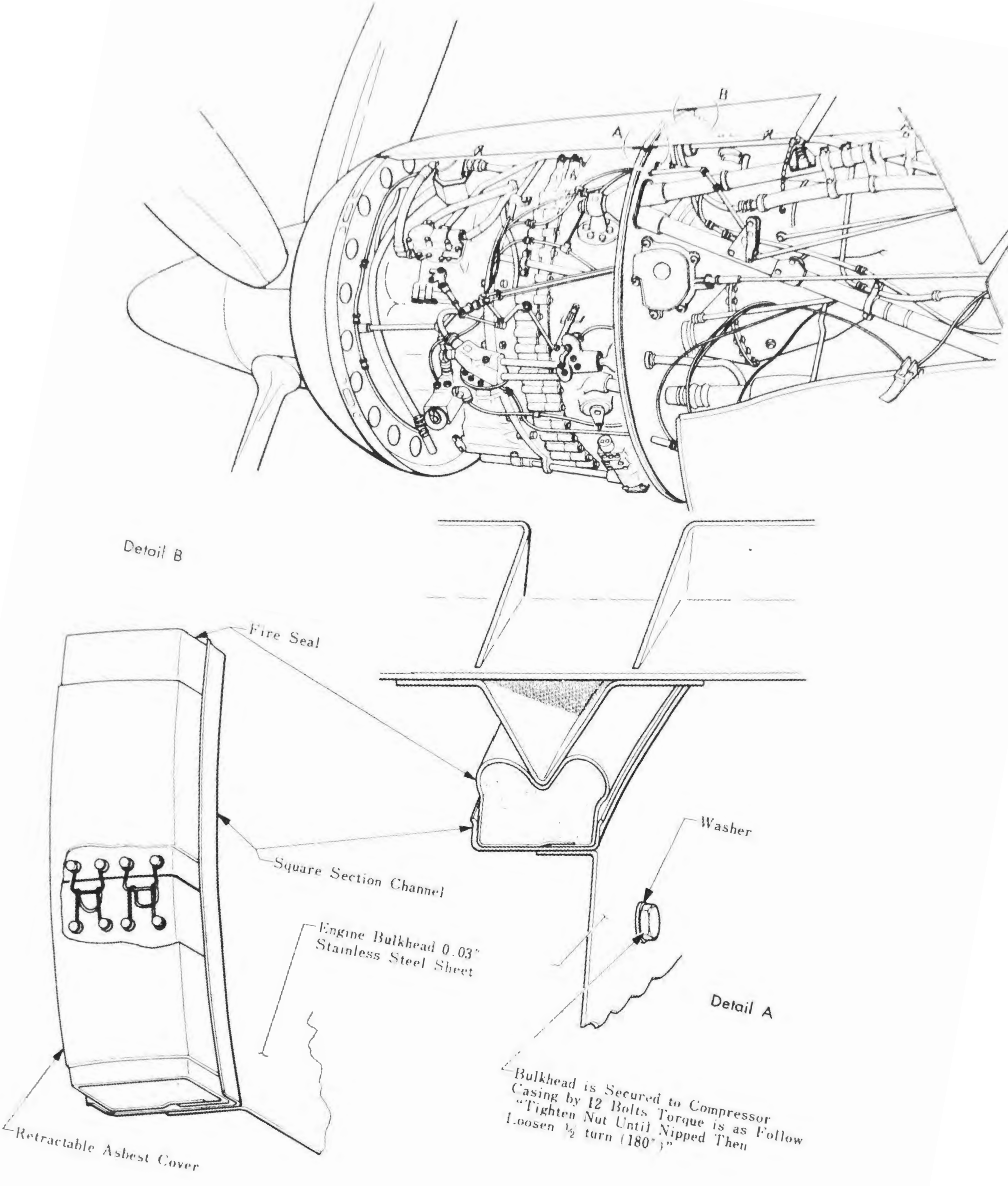


CAMLOC Fastener Section View



CAMLOC Fastener
4002 Series

Latches & Fasteners
Figure 4–5



Engine Fire Seal
Figure 4–6

4.4.3 Fairing (See Fig. 4-2, 3, 4, 5 and 6)

The fairing in the forward bottom section of the fire wall is of single skin construction made of light alloy, being fixed to the fire wall with bolts. This fairing can be removed if necessary.

On the L.H. and R.H. sides of the upper part of the fairing are provided latches with which the fairing can be fixed to the cowling side panels securely.

The latches are of the same kind as that used on the cowling. Inside the fairing are provided the outlet duct for the engine turbine cooling air and the hot air duct for the fuel heater.

4.5 Accessory Drive Gear Box

4.5.1 Summary (See Fig. 4-7)

The accessory drive gear boxes are installed between the airframe fire wall and the wing spar in the upper part of the L.H. and R.H. nacelles, respectively.

Between the engine and the gear box is provided a drive shaft which transmits engine power to the gear box.

The gear box is bolted to the sub-frame in the nacelle with brackets at the front end of the drive shaft and at both ends of the main casing.

At the front end supporting point, a support assembly with a ferobestos bush at the front end of the drive shaft housing is attached to the airframe fire wall with 4 bolts.

The L.H. side bracket of the main casing is attached to the sub-frame fitting through a lifting fitting, taking into account thermal expansion and manufacturing tolerances. In the bolt holes of the bracket are used the spherical bearings.

Around the gear box is provided a bulkhead which collects leaked or drain oil.

Around the unit are arranged the fire detectors. The gear box becomes accessible by opening the hinged top cover. On this cover is also provided an access cover through which the oil level can be checked with a dip stick.

4.5.2 Gear Box

L.H. installation

Type (C) P.T.G. 14/22 (with propeller brake, L.H. engine)

R.H. installation

Type (C) P.T.G. 14/23 (without propeller brake, R.H. engine)

4.5.3 Gear Box Drive (See Fig. 4-9 and 10)

The engine power is transmitted from the impeller shaft gear installed on the 2 stage compressor drive shaft (H.P. impeller shaft) to the gear box drive through 4 gears in the outlet casing and, then, to the gear box tunnel shaft through the universal joint, driving accessories through the reduction gears. The gear box shaft is provided with a quill shaft which fails when the gear box drive shaft is subjected to an overload.

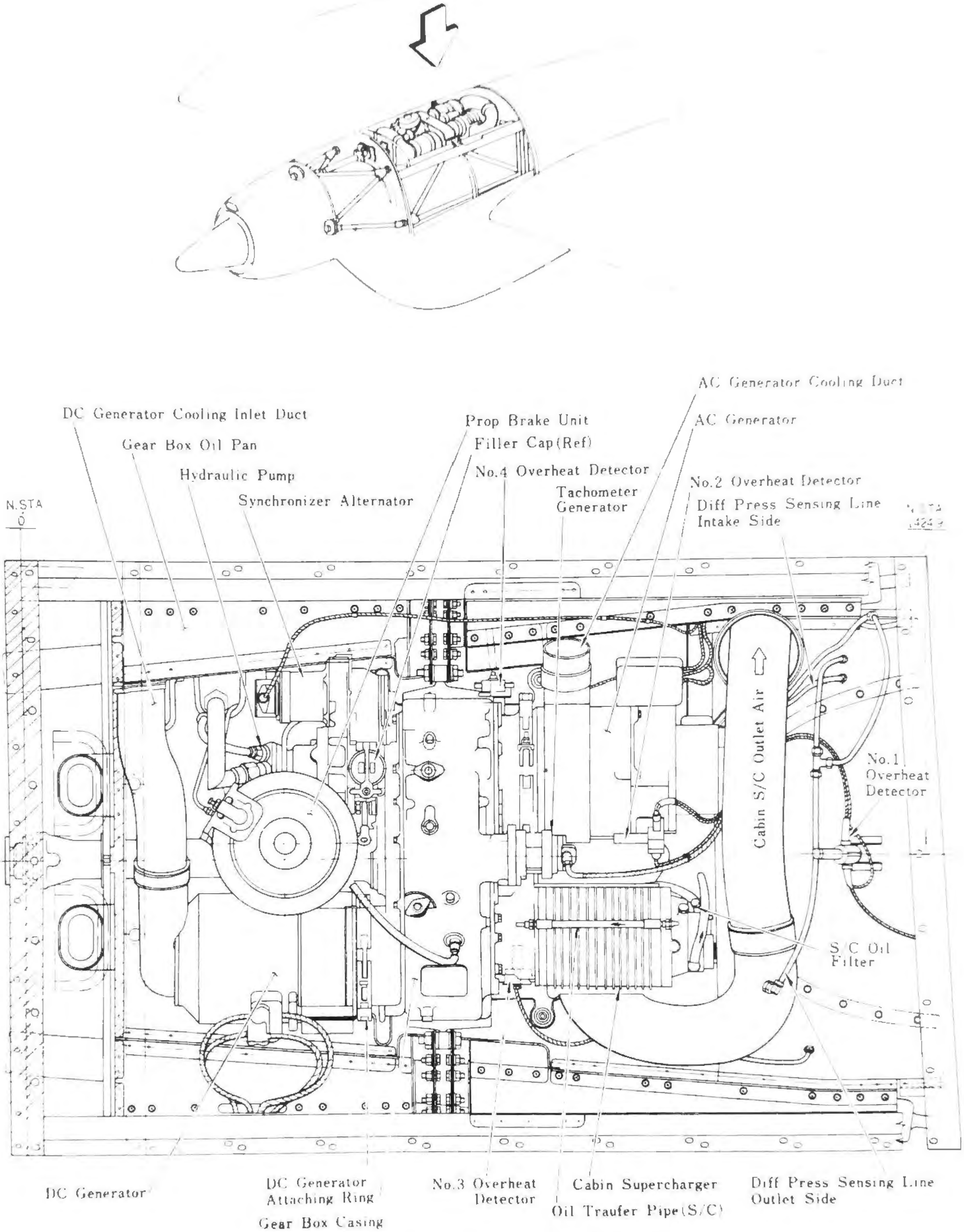
The quill shaft failing torque

Max. Safety Torque	11,600 lb.in
Gear Box Input Gear Ratio	0.3448

4.5.4 Gear Box Accessory Attachment (See Fig. 4-7 and 8)

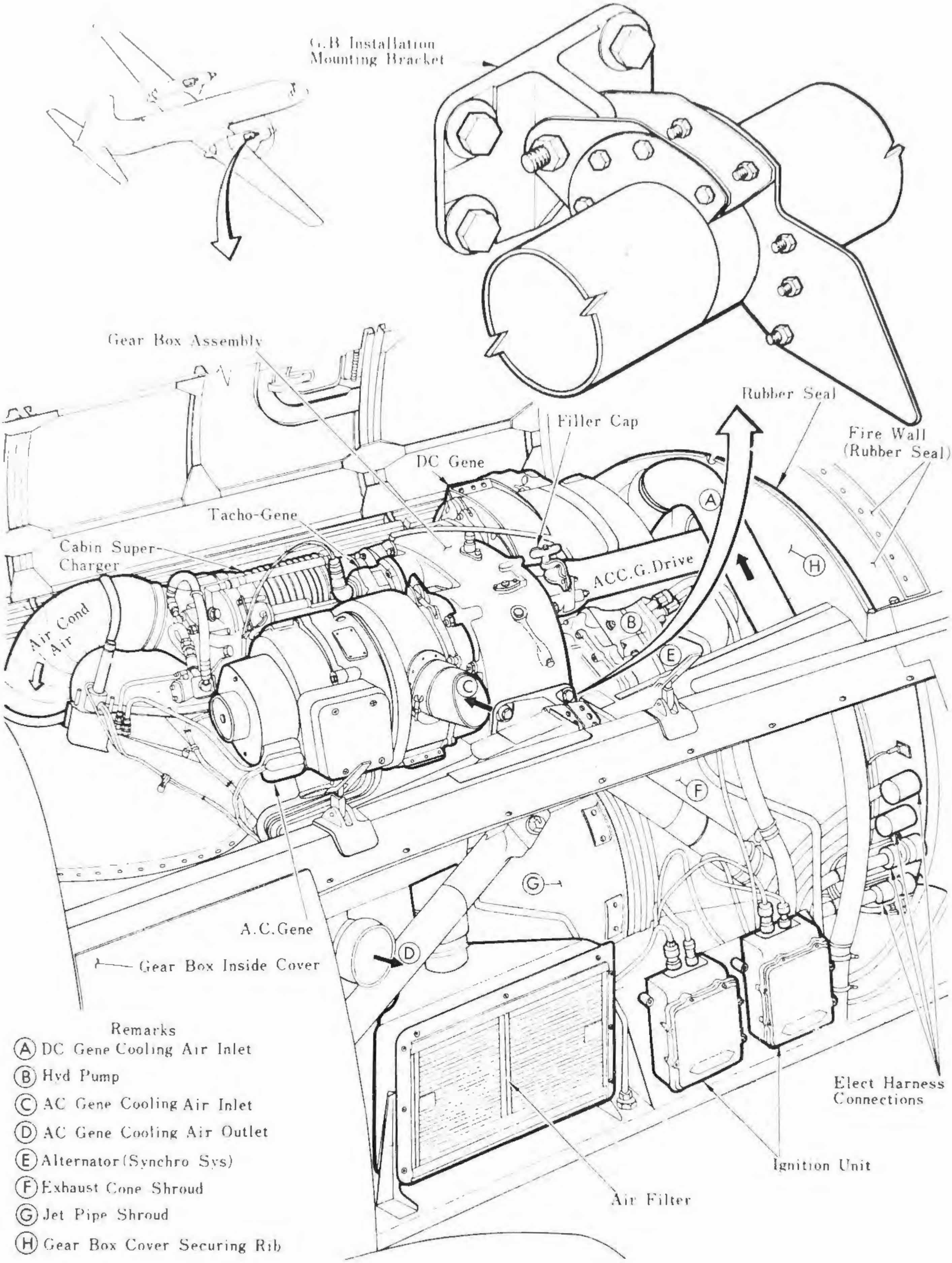
		Reduction Ratio (against gear box input)
Alternator	Rotax, 30kV	1.758
Tachometer Generator	Smiths	0.725
Cabin Supercharger	Godfrey	2.333
D.C. Generator	Jack & Heintz 12KW	1.490
Hydraulic Pump	Vickers	0.77
Synchronizer Alternator	Dowty Rotol	1.077
Propeller Brake	Dunlop	1.071

NOTE: For details of the gear box, see Dowty Rotol, Maintenance Manual 922A.



Installation of Accessory Gear Box

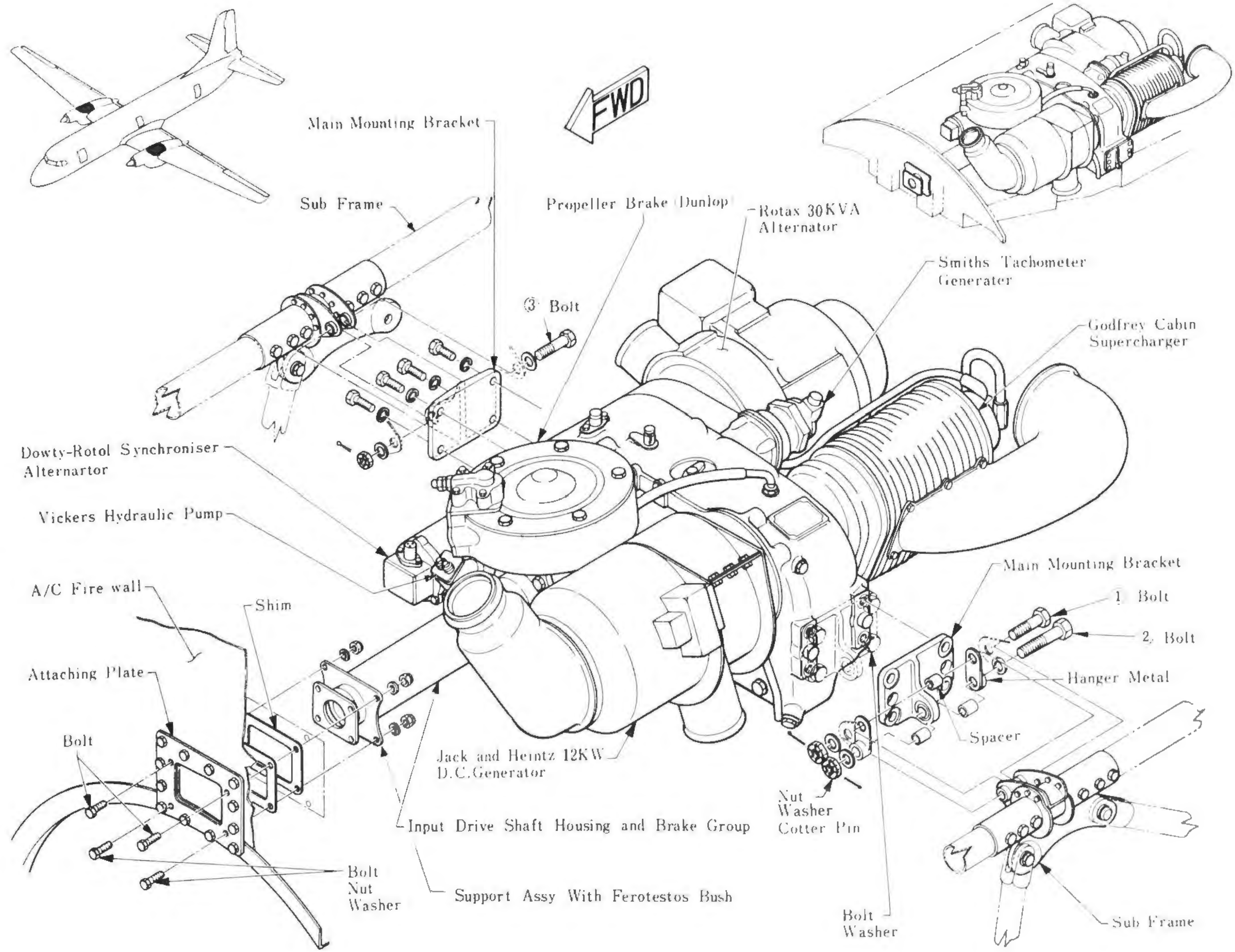
Figure 1-7



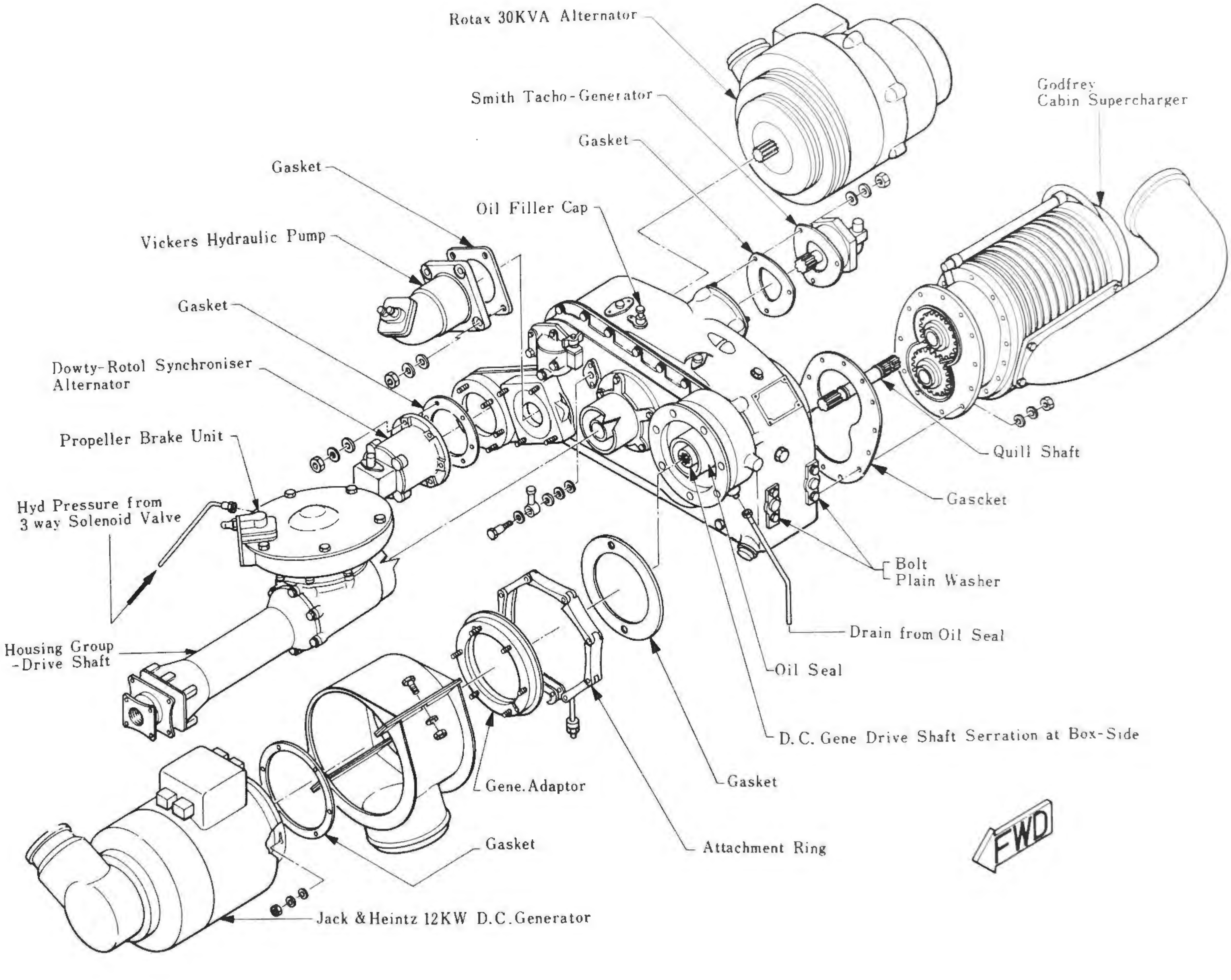
Remarks
- (A) DC Gene Cooling Air Inlet
- (B) Hyd Pump
- (C) AC Gene Cooling Air Inlet
- (D) AC Gene Cooling Air Outlet
- (E) Alternator (Synchro Sys)
- (F) Exhaust Cone Shroud
- (G) Jet Pipe Shroud
- (H) Gear Box Cover Securing Rib

Side View of Accessory Gear Box Installation (RH)

Figure 1-8



Installation of Accessory Gear Box
Figure 4–9



Accessory Gear Box Exproded View
Figure 4-10

4.6 Cooling and Ventilation System

4.6.1 Classification (See Fig. 4-11)

The cooling and ventilation system of the engine and gear box is described here.

The engine and the gear box areas are vented to cool them and accessories and to ventilate air around them. The nacelle is divided into the following 4 zones in view of fire protection:

Zone 1: This zone is located in the forward part of the engine between the rear part of the engine nose cowling and the engine fire wall.

Zone 2: This zone includes the engine hot section; combustion section and turbine section, extending rearwards from the aircraft fire wall, including the interior of the exhaust pipe.

Zone 3: This zone being the nacelle portion behind the aircraft fire wall, is divided into Zone 3 Upper and Zone 3 Lower. Zone 3 Upper is separated from Zone 3 Lower by the shear panel and wing structures.

Zone 4: This zone is an area where the accessory drive gear box is provided, located in the forward, upper part of Zone 3 Upper, being separated from Zone 3 Upper by a bulkhead made of aluminum alloy.

4.6.2 System (See Fig. 4-11)

The cooling air enters Zone 1 from the air intake scoops provided 2 ea. in the forward lower part of the L.H. and R.H. panels of the cowling and 1 ea. (oil cooler) in the upper part.

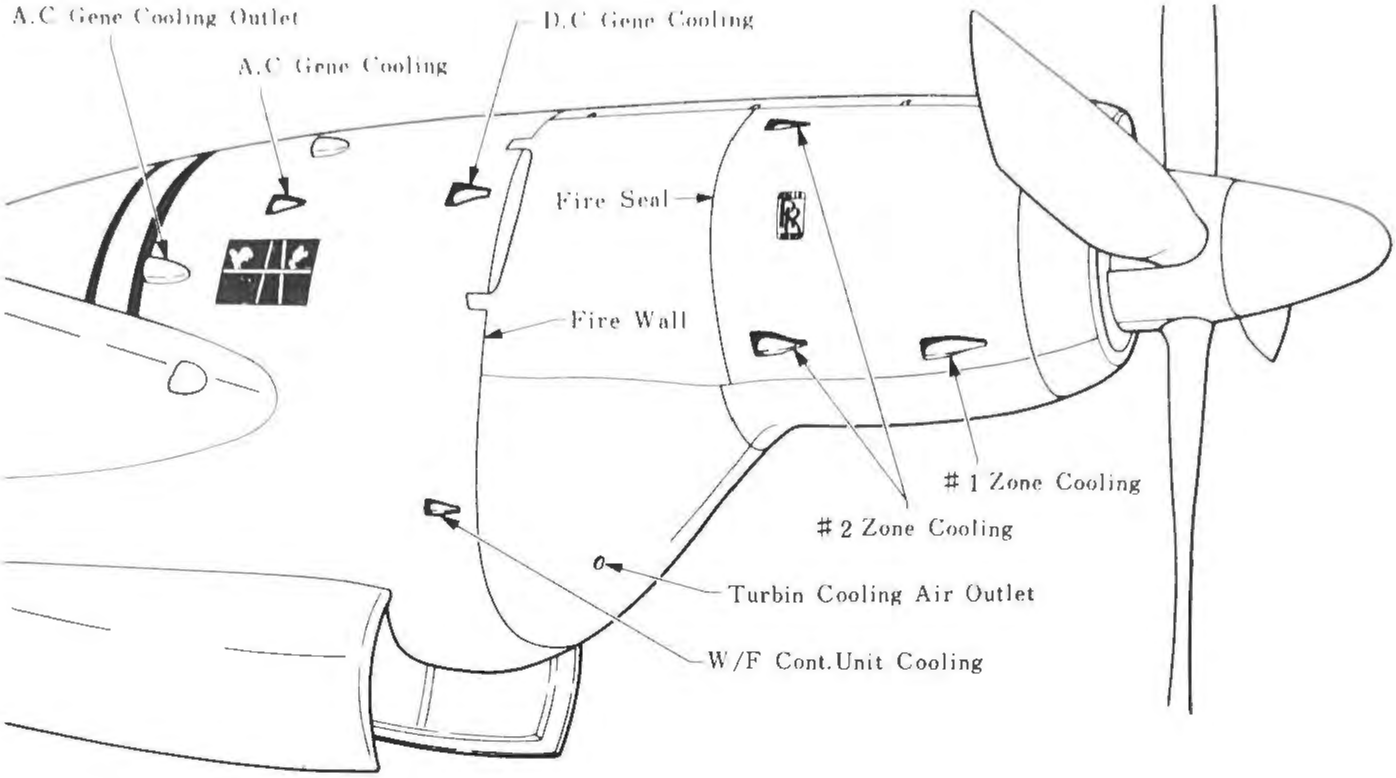
Air after cooling and ventilating Zone 1, is discharged from the engine oil cooler outlet port provided on the upper panel of the cowling.

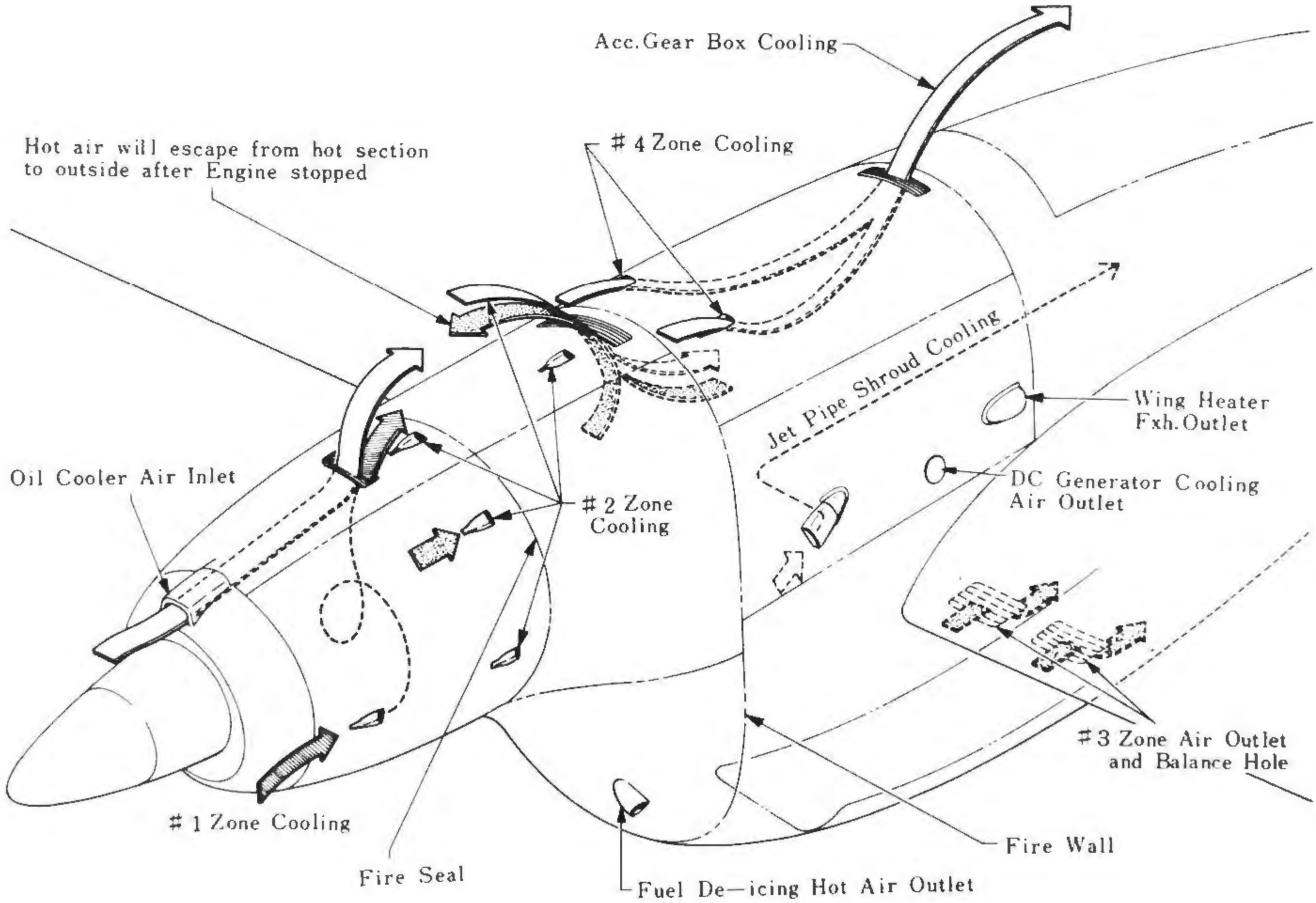
In Zone 2 are provided 7 air intake cowlings. The air intake scoops are provided 2 ea. on the L.H. and R.H. cowling side panels and two on the top cowling, respectively. The louver type air intake is provided 1 ea. in the rear of the top cowling.

After the air entered from the air intake cooled the hot section of the engine, it flows along the annular gap between the engine exhaust unit and the exhaust cone shroud into the jet pipe and it is ejected outboard together with the engine exhaust.

The air intake scoop on the top panel is provided to cool the forward and rear universal joints of the gear box drive shaft.

The louver type air intake not only takes in air, but also discharges warm air to speed up cooling of the turbine section after the engine is shut down.





Power Plant Cooling and Ventulation

Figure 4—11

The cooling air for Zone 4 enters from the 2 air intake scoops provided on the forward part of the gear box top cover and it is discharged from the louver type outlet provided in the rear of the gear box top cover after cooling the gear box and accessories.

After cooling the alternator control unit, air entered from the air intake scoop in the R.H. forward, lower part, ventilates Zone 3 Lower and is discharged from the louver type outlet located on the R.H. side of the nacelle close to the wing lower surface.

4.7 Exhaust System

4.7.1 Summary (See Fig. 4-12)

The exhaust system sends the hot gas from the turbine section over the wing upper surface and discharges it rearwards. The exhaust pipe consists of the exhaust cone shroud, jet pipe, blanket and jet pipe shroud. At its front end, the exhaust cone shroud is fixed to the aircraft fire wall with bolts, while its rear end can slide along the supporting fitting fixed to the jet pipe, permitting thermal expansion. To the rear end of the exhaust cone shroud are joined the jet pipe shroud on its outside and the jet pipe on its inside with flexible joints.

The exhaust pipes are interchangeable between the L.H. and the R.H. engines except the attachment of the supporting shaft for the rear support point which is symmetrical.

The exhaust cone shroud is installed around the engine exhaust unit. The cooling air of Zone 2 passing the gap between the above two, is led to the jet pipe by Venturi effect which is seen when the exhaust gas enters the jet pipe from the exhaust unit, making the coolings of Zone 2 more effective. The jet pipe is covered by blanket and furthermore by the shroud to prevent overheating of the structures around the jet pipe.

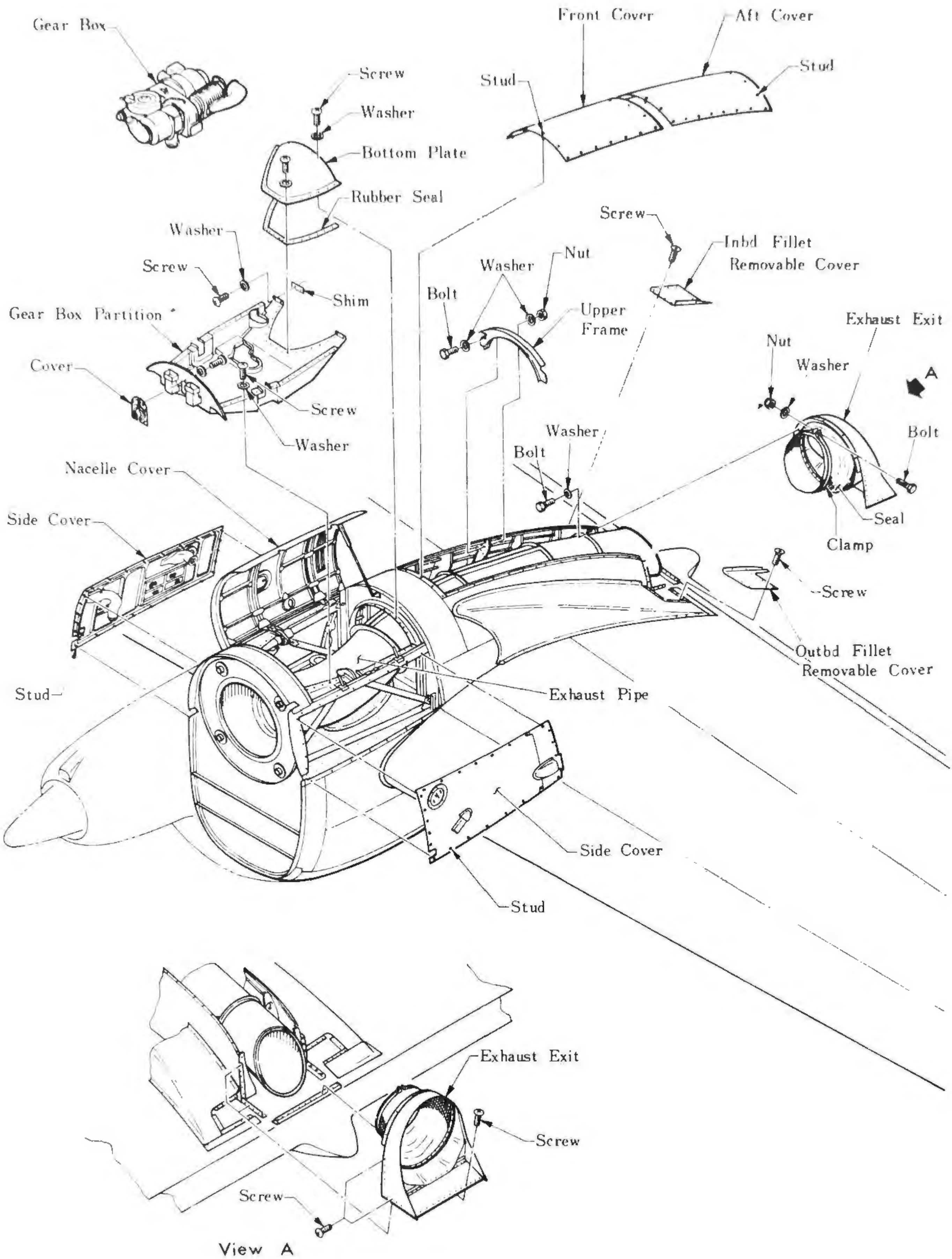
The cooling air taken in from the intake scoops on the sides of the nacelle passes the inlet duct of the exhaust cone shroud, passing the gap between the blanket and the jet pipe shroud and is discharged outboard from the rear end.

In order to prevent the exhaust gas discharged from the jet pipe from flowing back into the nacelle, the gap between the exhaust pipe and the nacelle structure is sealed with sealing cloth at the end.

4.7.2 Major Components (See Fig. 4-13, 14, 15, 16 and 17)

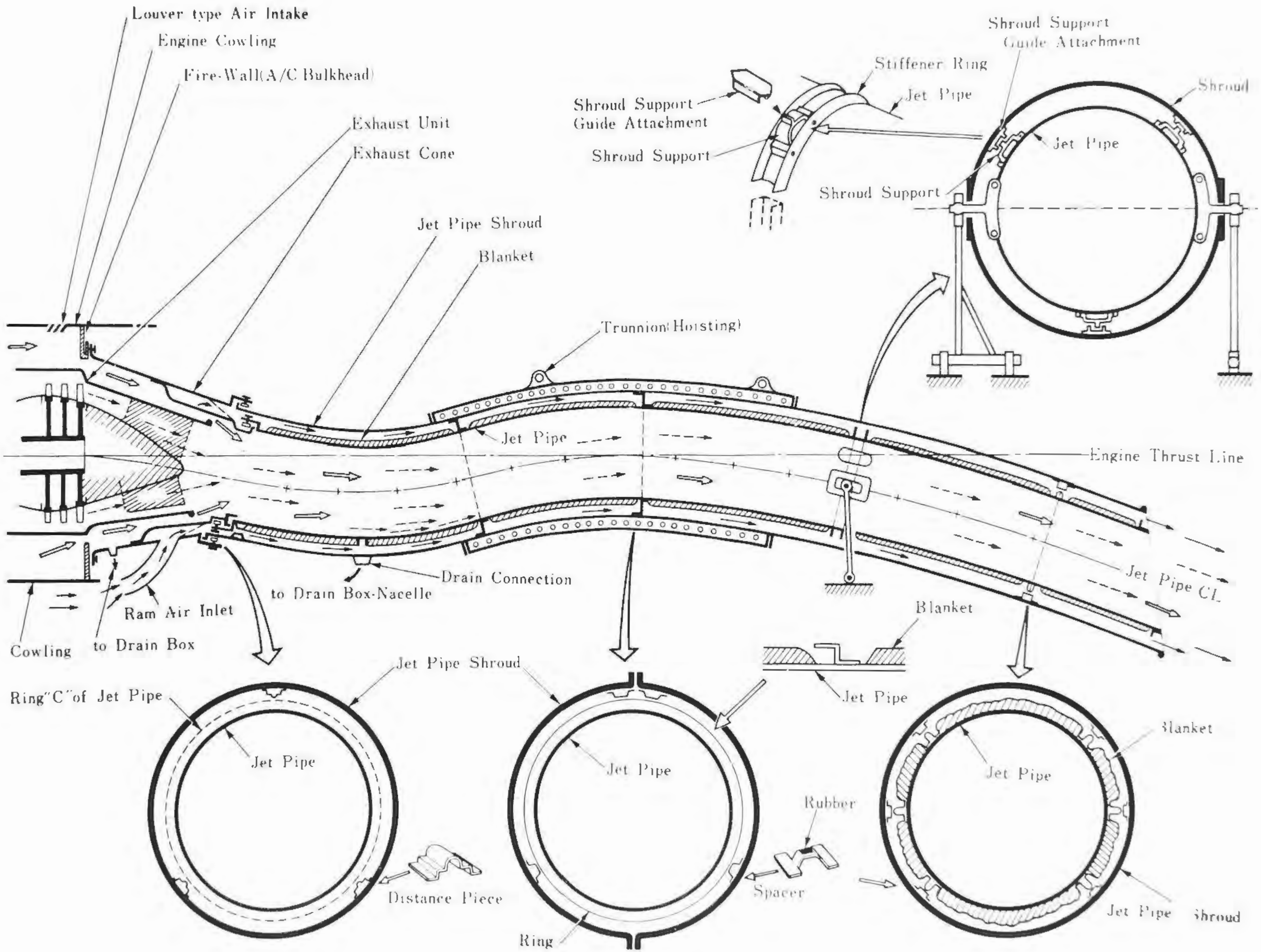
(1) Exhaust Cone Shroud

The exhaust cone shroud is of seam weld construction made of 347 corrosion resistant steel 0.032 in thick, approximately 480 mm long with the front diameter of approximately 635 mm and the rear diameter of 600 mm. The rear half is of double co-axial construction and air from the air scoop on the nacelle side is sent to the room between the two skins.

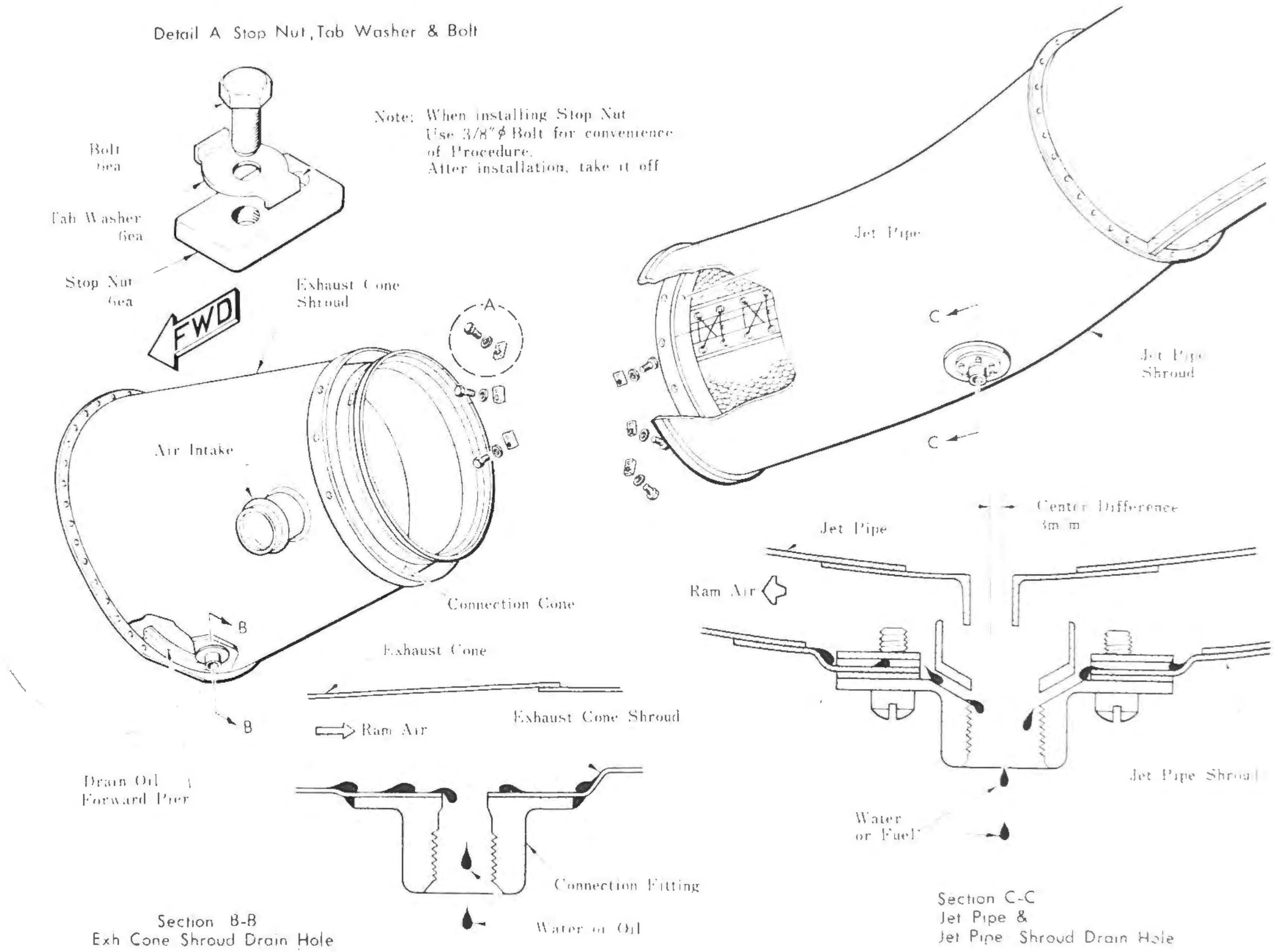


Exhaust Pipe Shroud Assy Remove Installation

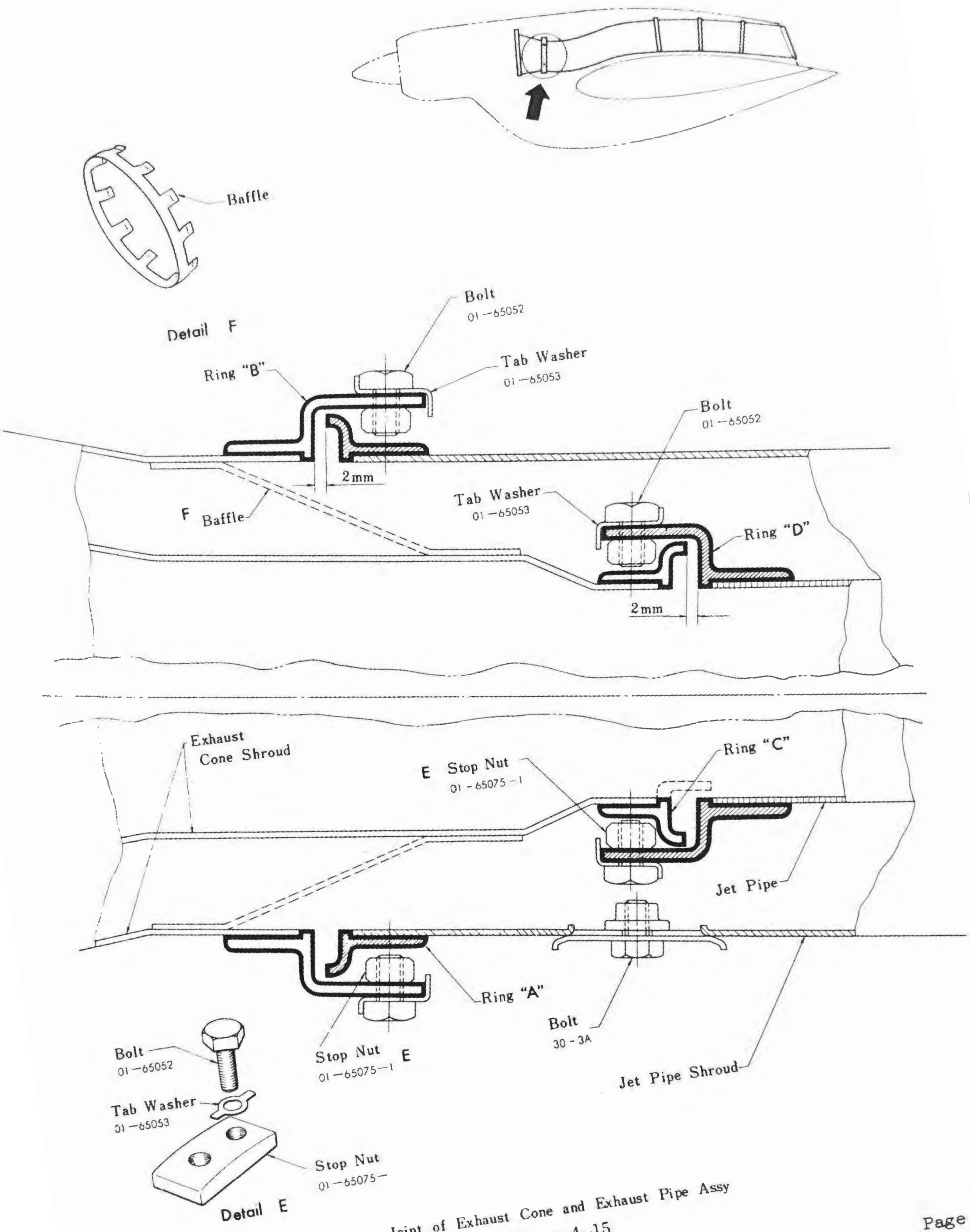
Figure 4–12



Exhaust System Functional Schematic
Figure 4-13

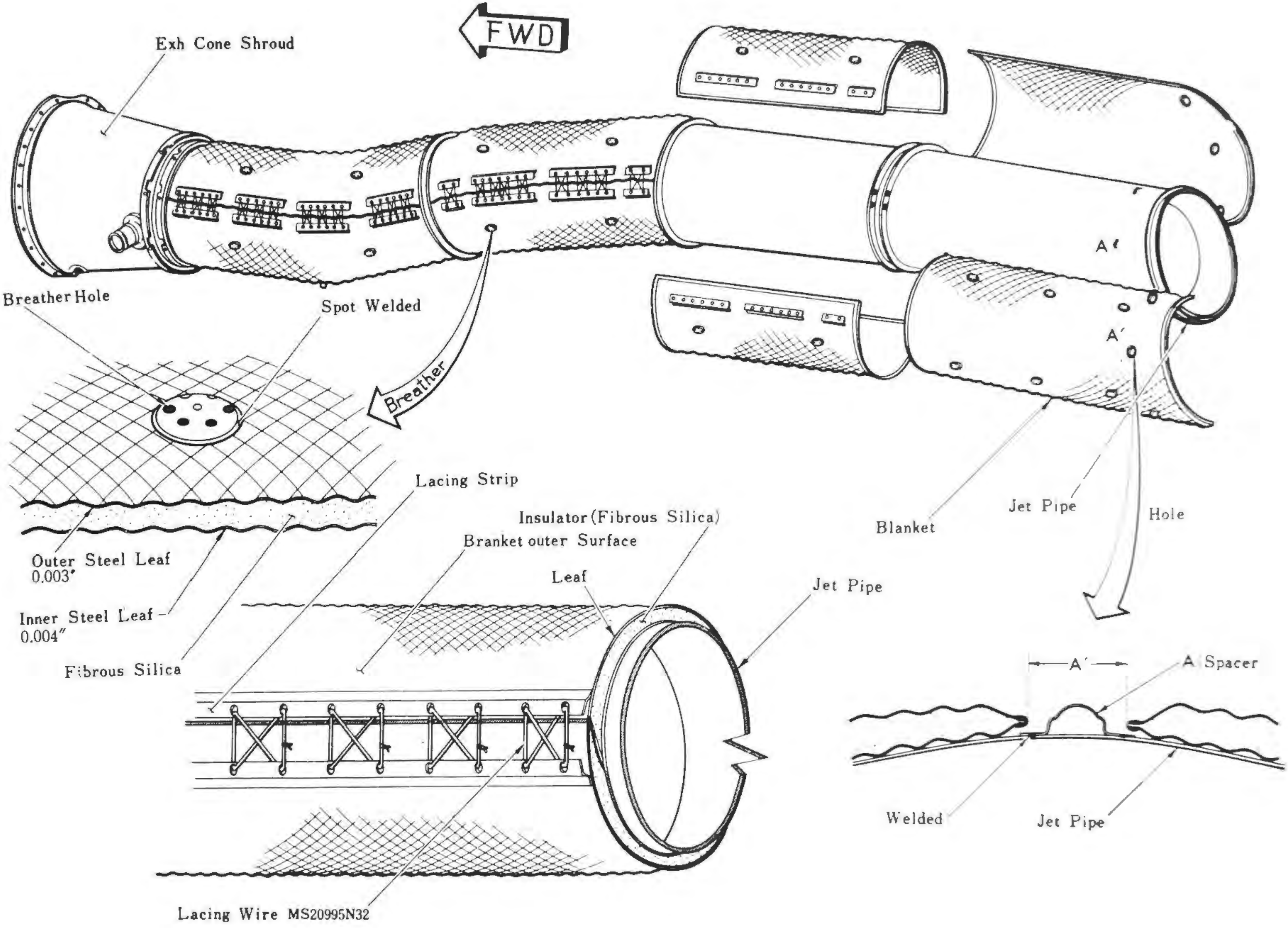


Installation of Joint & Drain
Figure 4-14



Joint of Exhaust Cone and Exhaust Pipe Assy

Figure 4–15



Blanket
Figure 4–16

(2) Jet Pipe

The jet pipe is of seam weld construction made of 347 corrosion resistance steel 0.032 in thick, approximately 3500 mm long, curved along the contour of the wing upper surface.

(3) Blanket

The blanket is made of heat shielding material sandwiched by corrosion resistant steel foils, the thickness being 0.5 in. The heat shielding material is made of laminated "Refrasil Fibrous Silica," fiber of silicon oxide, which is very light and can stand heat up to 1000°C.
In addition,it is a good insulator at elevated temperatures against heat and electricity. The stainless steel foils, 0.003 in thick outside and 0.004 in inside, are corrugated to increase strength and to permit expansion and its ends are welded to prevent entry of fuel, water etc.

In order to eliminate the pressure difference between the outside and the inside of the blanket when the engine is started or the operating conditions change, it is provided with breather holes which are covered by screens so that fluids can not enter them.

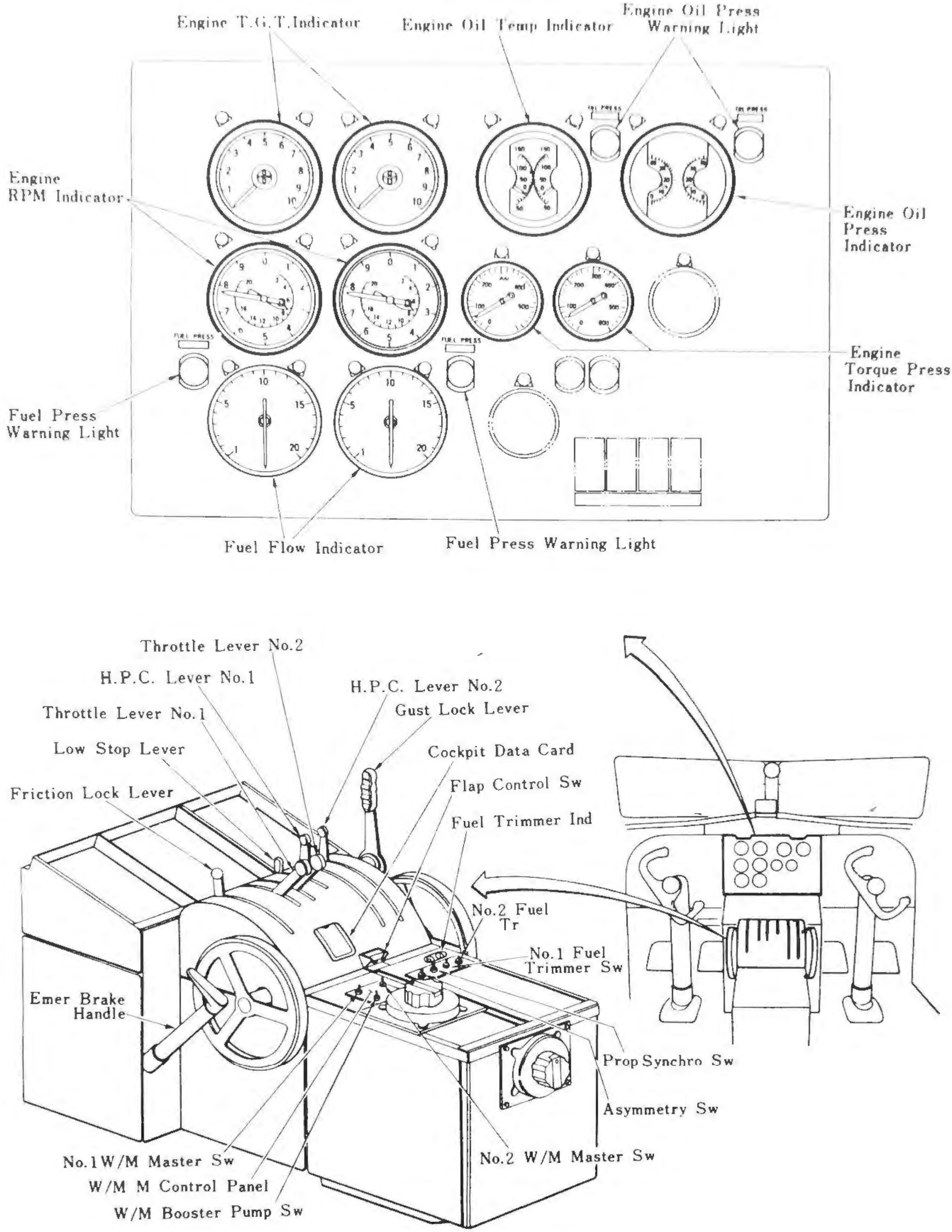
The blanket conforming to the shape of the jet pipe, consists of 4 pieces, each being divided into two parts, upper and lower.

(4) Jet Pipe Shroud

The jet pipe shroud is a structure of 2024-T4 seam welded pipes 0.025 in thick bolted together with a diameter of 470, split into 3 pieces.

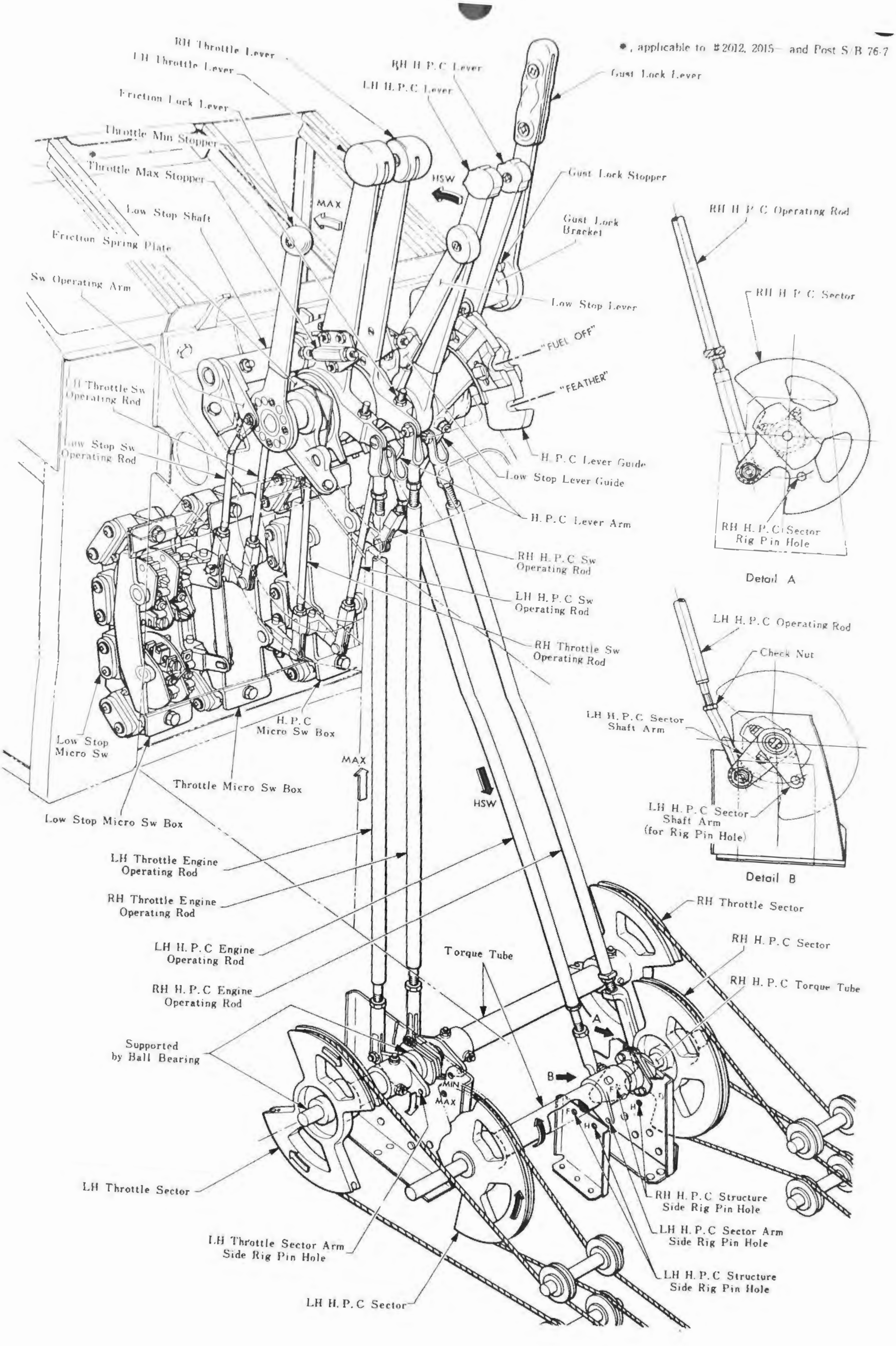
On the lower surface of the lowest position of the curved section corresponding to the jet pipe drain hole is provided a drain connection through which fuel accumulated in the jet pipe goes down to the drain box in the nacelle.

The intermediate section is divided into the L.H. and R.H. halves with the upper and lower flanges bolted together and on the forward and rear sections of the upper flange are provided two lugs for lifting used when the shroud is removed or installed.



Pedestal & Instrument Panel

Figure 4-17



Pedestal Construction General View
Figure 4-18

4.8 Engine Control System

4.8.1 Summary of Power Control (Fig. 4-18)

The power control system consists of the following sub-systems:

Throttle Control System
Trim Control System
H.P. Cock Control System

The above controls are operated from the pedestal in the cockpit. On the pedestal are provided three levers (low stop, throttle and H.P.C.). On the lower ends of these levers are located micro switches.

(1) Features of Pedestal

A. The throttle lever, low stop lever or H.P.C. lever can be removed from the pedestal easily, independent of the others.

B. Not to mention the throttle micro switch which requires fine adjustment, the switches for the other two levers can be finely adjusted.

C. Micro switches (amounting to 22) are neatly arranged in the comparatively scanty forward space of the pedestal. Any one of them can be easily replaced if necessary.

(2) Features of Each Lever Control Linkage

A. On the ends of cables in the L.H. and R.H. nacelles are installed the end pulleys symmetrically. In the L.H. nacelle, the synchro corrector unit is tied in the throttle lever control.

B. When both throttle and trim control systems are rigged, it is important to confirm the datum position of the corrector unit.

C. The end pulley (nacelle quadrant) and the engine control box are linked together with push pull rods and control rods.

D. As long as the aircraft side rigging is concerned, the throttle system, H.P.C. system or trim system moves independent of the others. However, they can move independently only up to the engine control box and from this point on, they are mutually interrelated in their movement.

4.8.2 Composition and Functions of Pedestal

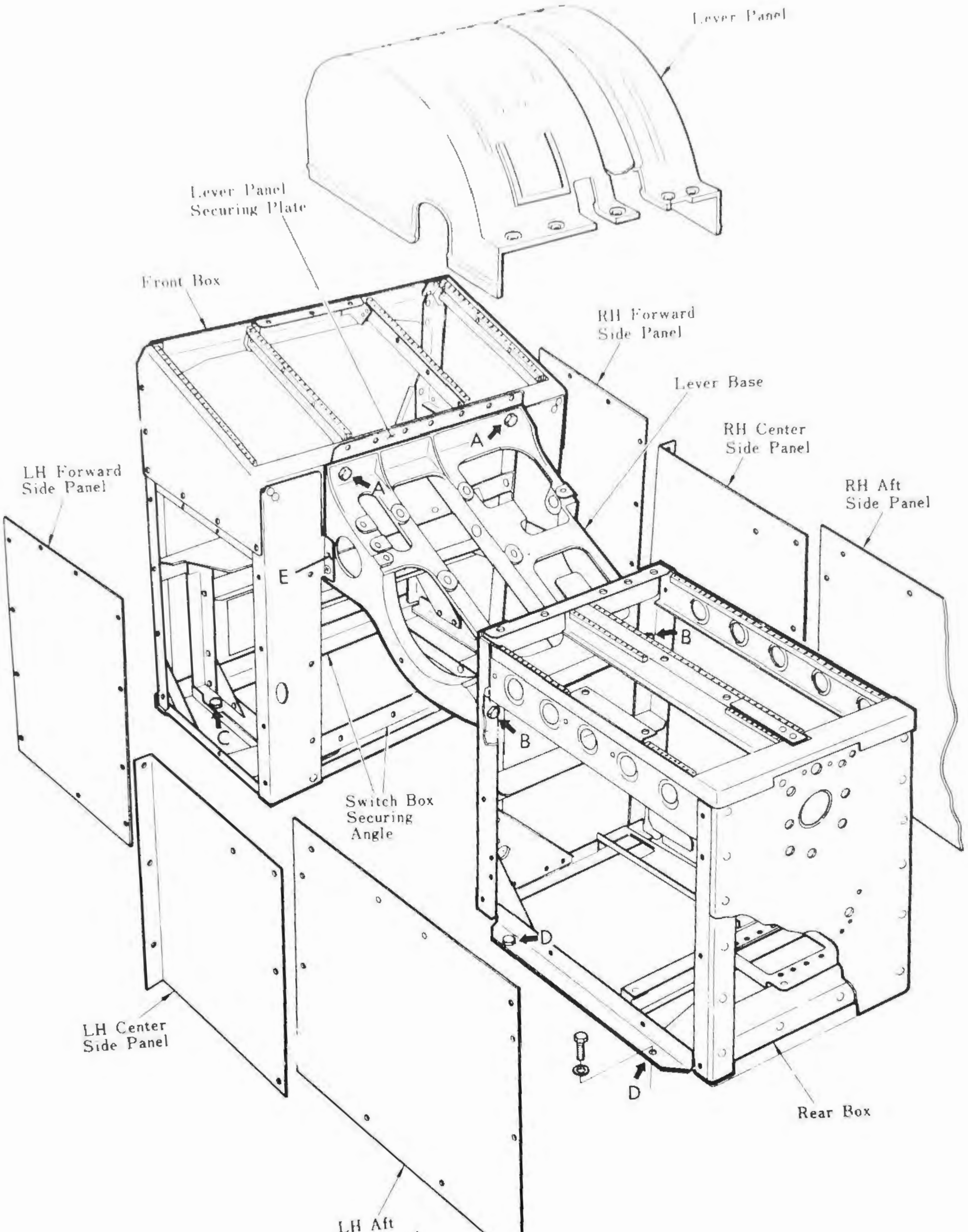
(1) Structure of Pedestal Frame (Fig. 4-19)

The pedestal consists primarily of the following three parts:

Front box .... In the box is contained a box in which micro switches are installed.

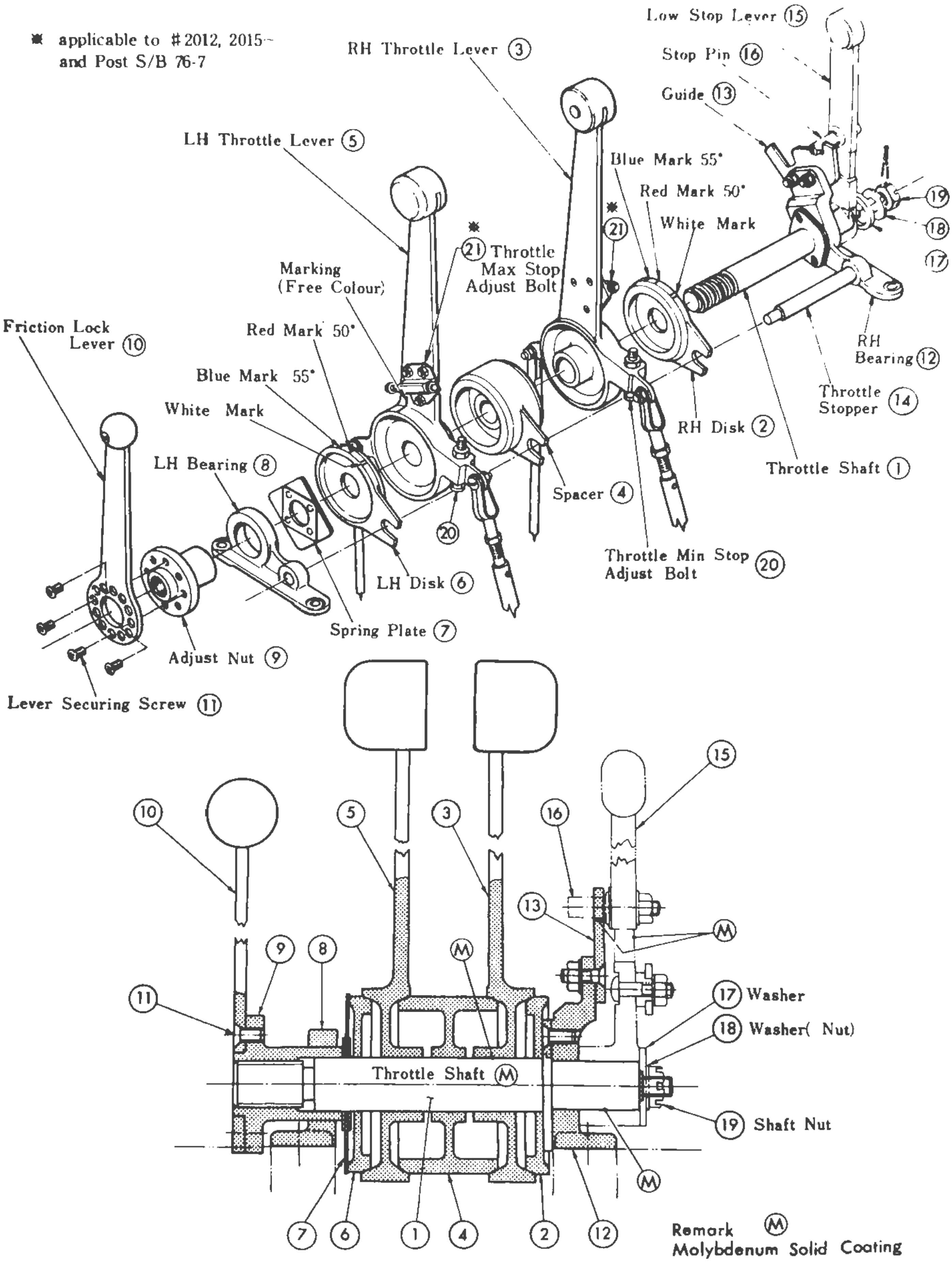
Lever base .... On the base are installed levers and their shafts.

Rear box .... On the upper surface are installed a control panel for the W/M and trimmer.



Pedestal Frame Construction

Figure 4-19



Throttle Friction Lock on Pedestal
Figure 4-20

In addition, on the pedestal are installed the lever panel covering the lever base and the side panels covering the both sides of the pedestal.

The front box is fixed to the floor beam with the four bolts located at the four corners of the bottom.

The lever base made of thick aluminum alloy casting bridges the front box and the rear box.

Its forward end is fixed to the front box with two bolts and its recessed portion just fits on the front box.

The rear box is fixed to the floor beam with the four bolts on the bottom.

The switch boxes (low stop, throttle and H.P.C. switch boxes from the left to the right) are attached to two angles in the front box.

(2) Details of Throttle Lever (Fig. 4-20)

The throttle lever can be rotated from the minimum position to the maximum position around the throttle shaft. On the both ends of the throttle lever are attached the discs and on its left side provided the throttle friction lever which is mounted on the throttle shaft.

To fix the throttle lever at a given position, the friction lock lever is used. Then the adjust nut pushes the spring plate which, in turn, pushes the disc, locking the throttle lever.

At the root of the throttle lever and the L.H. and R.H. discs are provided color marking which is necessary for rigging. Be careful especially not to erase the marking on the discs.

Reference point at 55° .... Blue mark

Reference point at 50° .... Red mark

Reference point for throttle
micro switch .... White mark

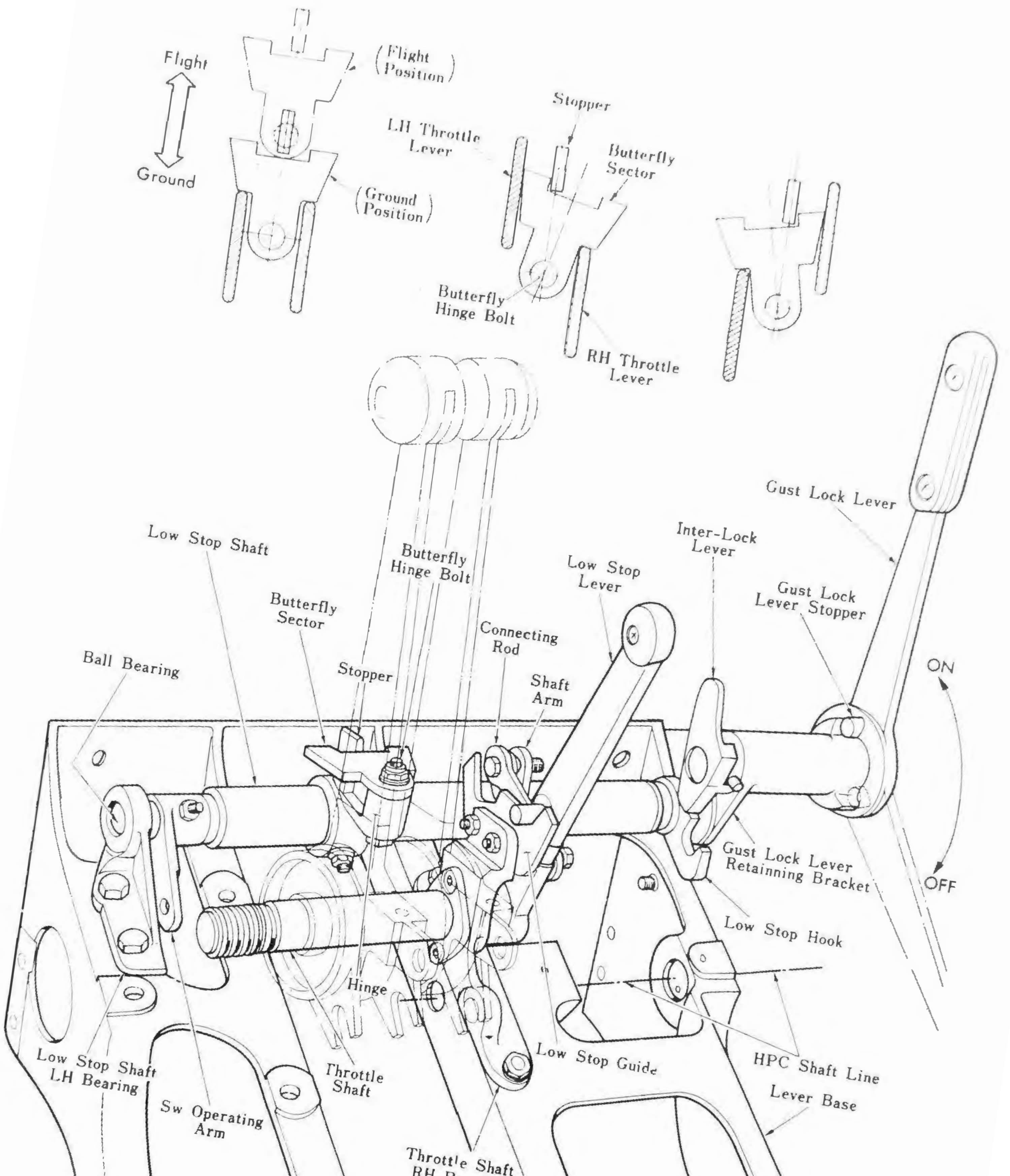
The primary stoppers for the throttle travel irrespective as to whether they are max. stops or min. stops, are located in the control box on the engine side.

If the throttle lever is moved, the forward arm at the root moves the throttle micro switch group actuating rod.

The rear arm moves the throttle rod for the engine power control.

(3) Details of Low Stop Lever (Fig. 4-21)

The left end of the low stop shaft is supported by a ball bearing fitted in a bracket. The bracket is mounted on the lever base with two bolts.



Gust Lock & Low Stop Lever on Pedestal

Figure 4-21

The right end of the shaft is supported by the same ball bearing. This bearing is caulked in the gust lock lever mounting bracket.

The bracket itself is mounted on the front box side and the lever base side with two bolts, respectively.

On the low stop shaft are mounted two arms, a hinge and a hook, integral with the shaft.

The switch operating arm on the left hand moves the low stop micro switch actuating rod. The low stop hook on the right hand is linked to the inter-lock lever of the gust lock system.

If the low stop lever is pushed forward, the shaft rotates forward and the hinge at the center of the shaft catches the butterfly sector. This butterfly sector prevents both throttles from opening fully at the same time when the gust lock is on.

In order to determine the low stop lever positions clearly, the flight position and ground position dents are provided on the guide.

As the movement of the low stop lever is affected by the gust lock lever position, the low stop lever can not be placed in the flight position if the gust lock lever is not disengaged. The ground position can be obtained if the low stop lever is pulled up and rearwards.

(4) Details of H.P.C. Lever (Fig. 4-22)

The H.P.C. lever rotates around the H.P.C. shaft and the H.P.C. lever guide is mounted on the H.P.C. shaft with the guide securing bolts.

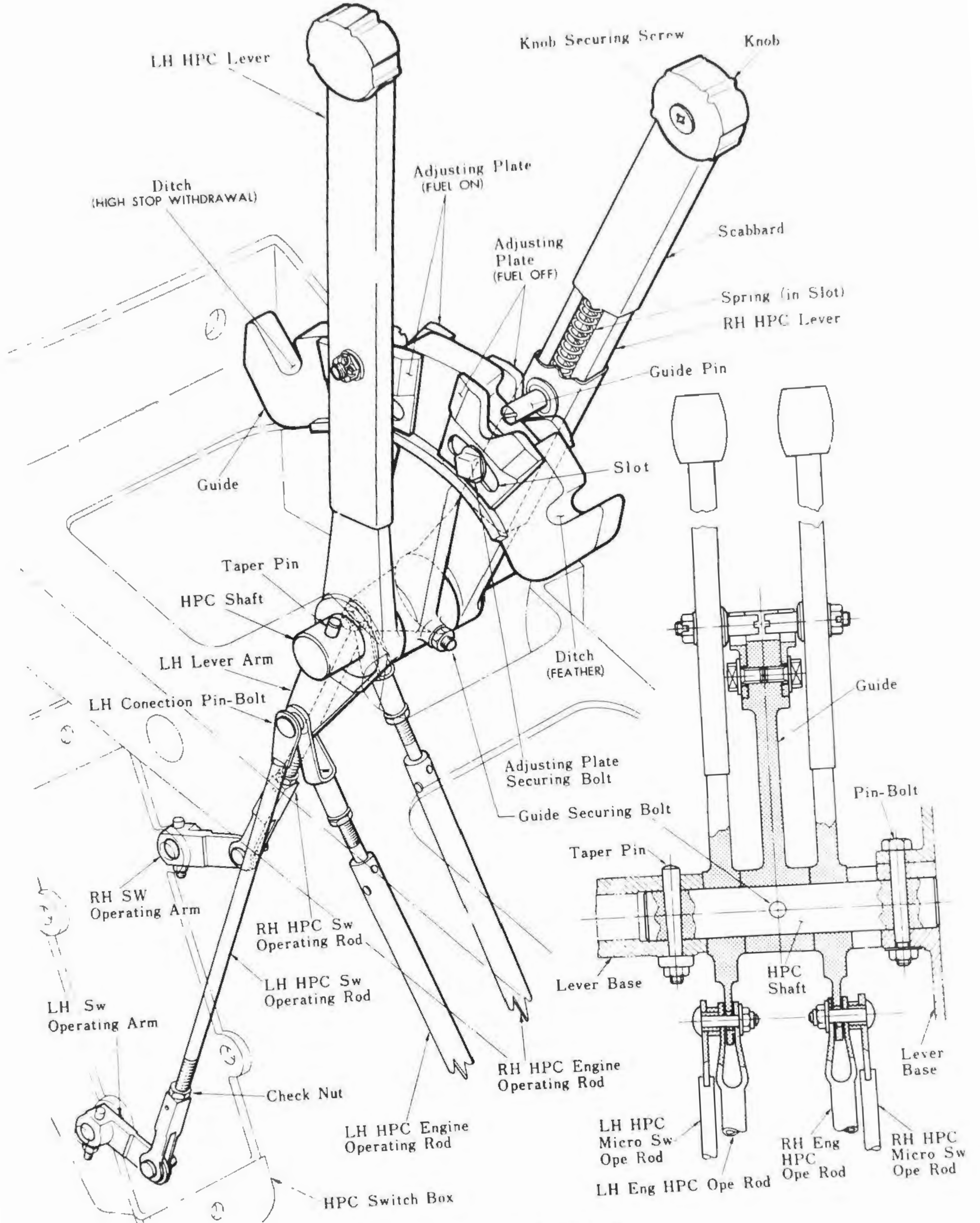
The L.H. and R.H. levers are connected to the rods actuating the L.H. and R.H. micro switches in the switch boxes, respectively.

At the same time, the L.H. and R.H. engine operating rods are connected to the lever arms. The guide has the following four lever position dents:

High Stop Withdrawal
Fuel On
Fuel Off
Feather

If the H.P.C. lever is placed in the high stop withdrawal position, the "L.O." mark is selected in the control box on the engine side. The H.P.C. control system is adjusted at this position. "FUEL ON" and "FUEL OFF" positions are determined with the dent positions of the guide by adjusting the H.P.C. lever slots to the engine installed.

"FEATHER" position is so designed that the lever is caught by "F" stopper of the engine control box on its way and it serves as the reference point when the micro switches are adjusted.



HPC Lever on Pedestal

Figure 4-22

4.8.3 Relativity of Gust Lock, Low Stop and Throttle (Figs. 4-21 and 23)

The throttle and the low stop are mechanically connected to the gust lock lever so that the aircraft can not be taken off without disengaging the gust lock.

(1) Both L.H. and R.H. throttle levers can not be advanced to the max. power position when the gust lock is on. Either one can be moved to the position at a time.

(2) The low stop lever can not be moved manually from the ground position to the flight position when the gust lock is on. On the contrary, the gust lock can not be engaged when the low stop lever is in the flight position.

(3) When the gust lock is disengaged, the L.H. and R.H. throttle levers can be moved to the max. position at the same time and the low stop levers can be moved manually to the flight position easily. If the pilot advances both throttle levers, paying no attention to the low stop levers, the throttle levers drag the low stop levers to the flight position.

4.8.4 Composition of Micro Switch Groups (Fig. 4-24)

(1) Composition of Groups

The micro switch groups consist of the following three:

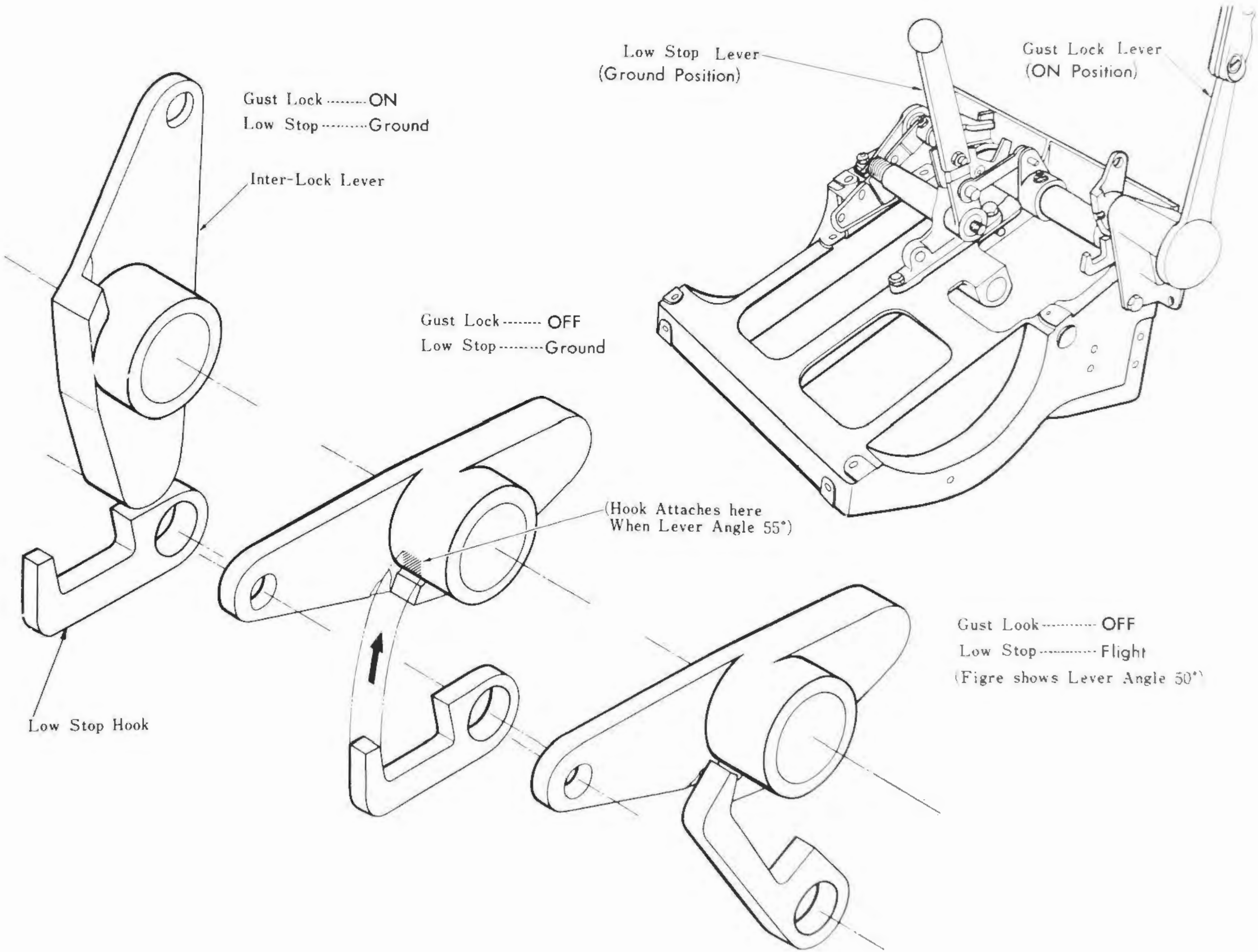
Throttle Switches	F1 to F8 (8 micro switches)
Low Stop Switches	L1 to L7 (7 micro switches)
H.P.C. Switches	a, a', b, b', c, c', d (7 micro switches)

(2) Composition and Functions of Adjuster

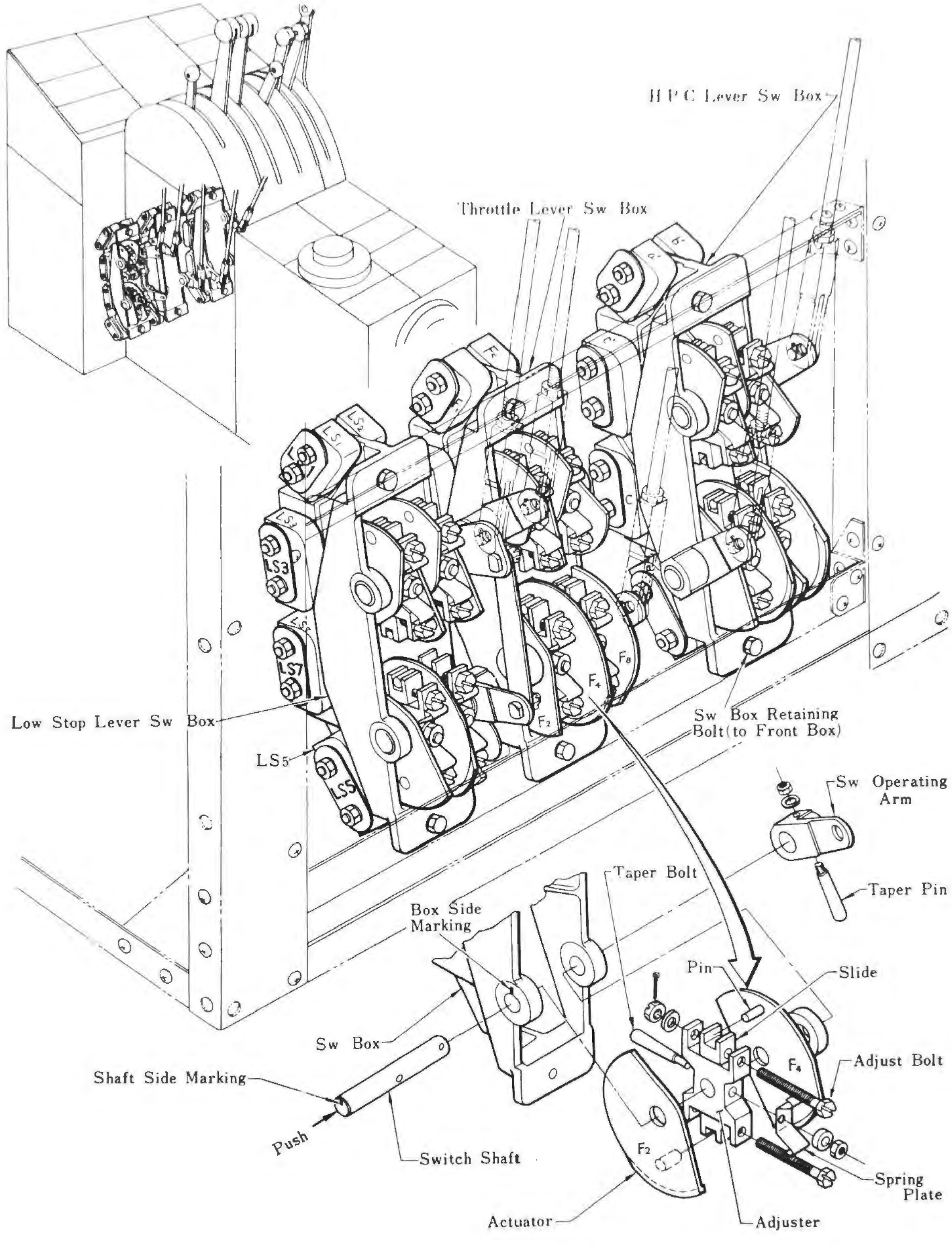
On the adjuster in H shape are provided slides 1 ea. on the upper and the lower parts. The slide with thread inside can be moved laterally by rotating the adjust bolt.

The switch shaft has been so designed that it moves together with the two adjusters. The actuators are essentially cam plates with different shapes. The locking positions of the pins are all different slightly.

NOTE: The pitch of the adjust bolt of the micro switch actuator to be adjusted is 0.8 mm. The maximum amount of correction is approximately 8° of the rotating angle of the actuator which correspond to approximately 1,200 r.p.m. of engine speed at the throttle switch.



Interrelationship of Gust Lock and Low Stop
Figure 4-23



Micro Switch & Cam Installation

Figure 4-24

(3) Summary of Types and Operation of Micro Switches (Fig. 4-25)

Types of Switches

a. BZ-7RDT and BZ-7 RWT822

Since the terminals are of normal-open type or normal-close type depending on usages, the electrical circuit may be open even when the switch is pushed in and it may be closed even when the switch is released.

b. BZ-3YDT

As both terminals (normal open and normal closed) are in use, the open and closed electrical circuits exist at the same time when the switches are in "PUSH" and "RELEASE" conditions.

(4) Summary of Throttle Micro Switch

The following micro switches come into action successively as the lever moves from the min. position to the max. position:

F1, F2 ..... If the engine throttle is retarded to this point on its way to the idle position when the main gear is not down-locked, the landing gear warning bell rings. This is intended to prevent landing with landing gear up.

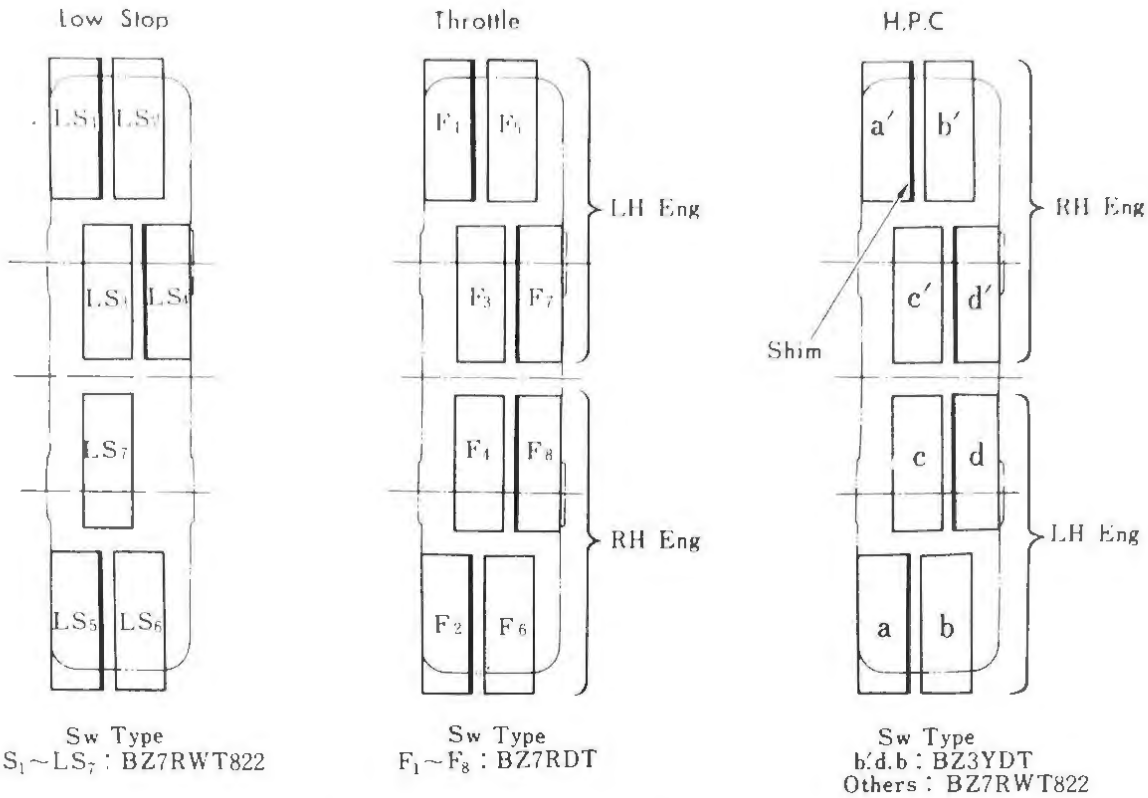
F3, F4 ..... This switch closes the auto feather circuit of the propeller control system at around 12,800 to 13,000 rpm. If the torque value drops below 50 psi while the lever is located in a more advanced position, the propeller auto-feathering takes place.

F5, F6 ..... This switch opens the spill valve of the air control system at 380 lb/hr of fuel flow. This is intended to smooth acceleration at the time of engine starting. If the low stop lever is placed in the ground position, the ground spill takes place. If it is in the flight condition, the ground spill does not take place.

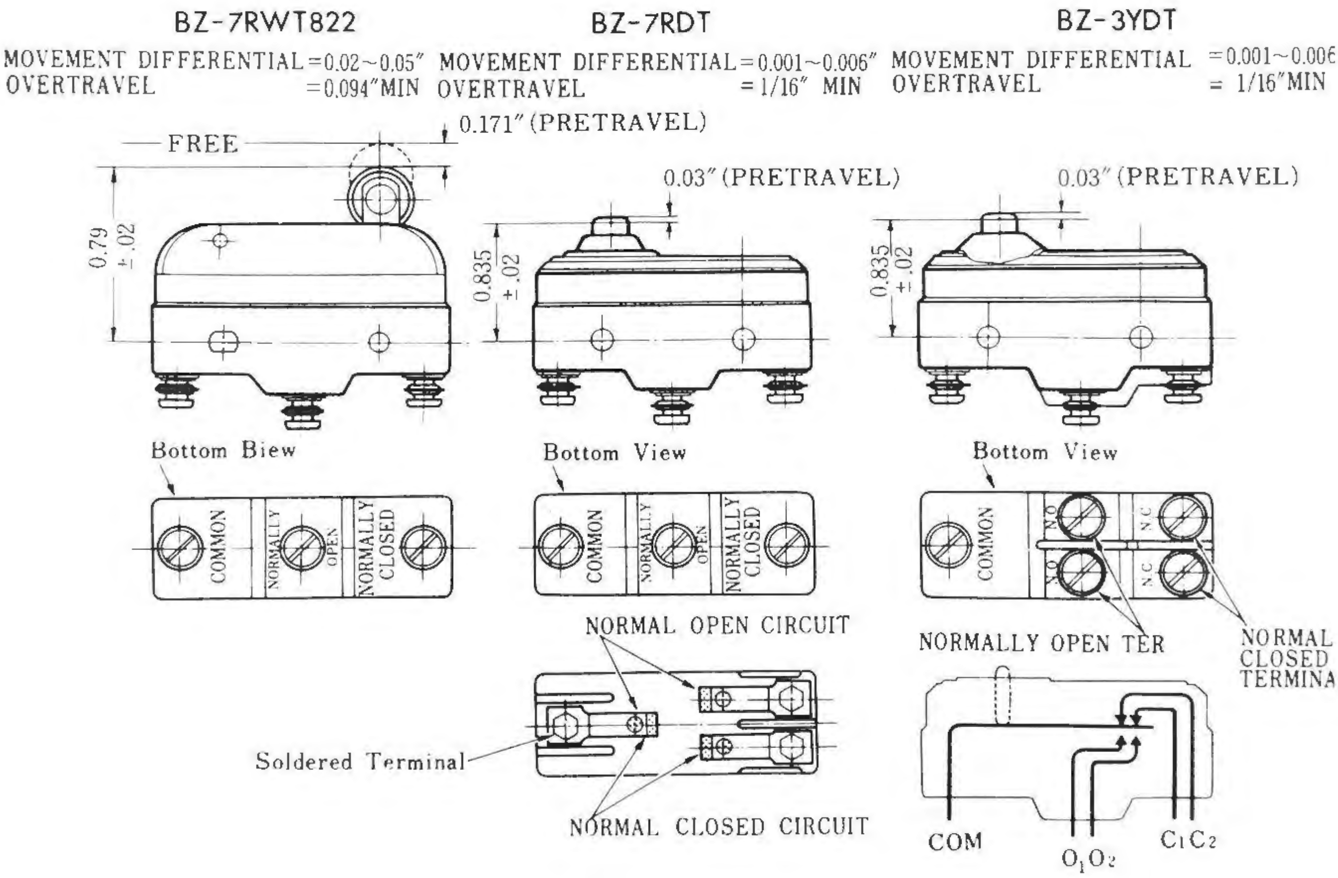
F7, F8 ..... This opens the spill valve so that the take-off power is not used for accessory driving at 14750 to 14950 rpm.

(5) Summary of Low Stop Micro Switch

LS1, LS2.... If the lever is in the flight position, this closes, performing the following functions: If the propeller pitch moves 2° below the flight fine pitch during flight, the warning light comes on for corrective action and the solenoid is energized to coarsen the pitch. As the pitch is coarsened, the blade cam cuts off the electric power supply.



Micro Sw Groups on Pedestal
(Looking from Aft to Fwd)



Three Types of Micro Switches

Micro Switches Groupes on Pedestal

Figure 4-25

LS3, LS4..... This closes when the lever is in the ground position, performing the following functions:
This energizes the solenoid which release the flight fine pitch stopper, permitting fine pitch adjustment up to 0^o on the ground.

LS5, LS7..... This closes when the lever is in the ground position. This energizes RL5 relay to generate 150V wild frequency AC during engine run up on the ground.

LS6 .... This opens when the lever is in the flight position. This switch cuts off electric power to F5 and F6 so they do not come into action in flight. That is to say, this does not permit the spill valve to open in flight even though the lever is retarded below 11,000 rpm.

(6) Summary of H.P.C. Lever Micro Switch

The working points of the switch varies as shown in the following table, depending on the positions of H.P.C. lever:

	High Stop Withdrawal	Fuel ON	Fuel OFF	Feather
aa'	Close	Close	Close	Open
bb'	Close	Close	Open	Open
cc'	Open	Open	Open	Close
d	Open	Open	* Close	Open

"* Close" indicates that the propeller brake circuit is made when H.P.C. lever is in "Fuel OFF" position.

The switch a is provided in the auto feather circuit of No. 2 engine and No. 2 engine can not be auto-feathered if No. 1 engine is feathered already.

Consequently, the switch a comes into action only when

a. No. 1 auto coarsening relay is dead,

b. No. 2 engine torque is below 50 psi,

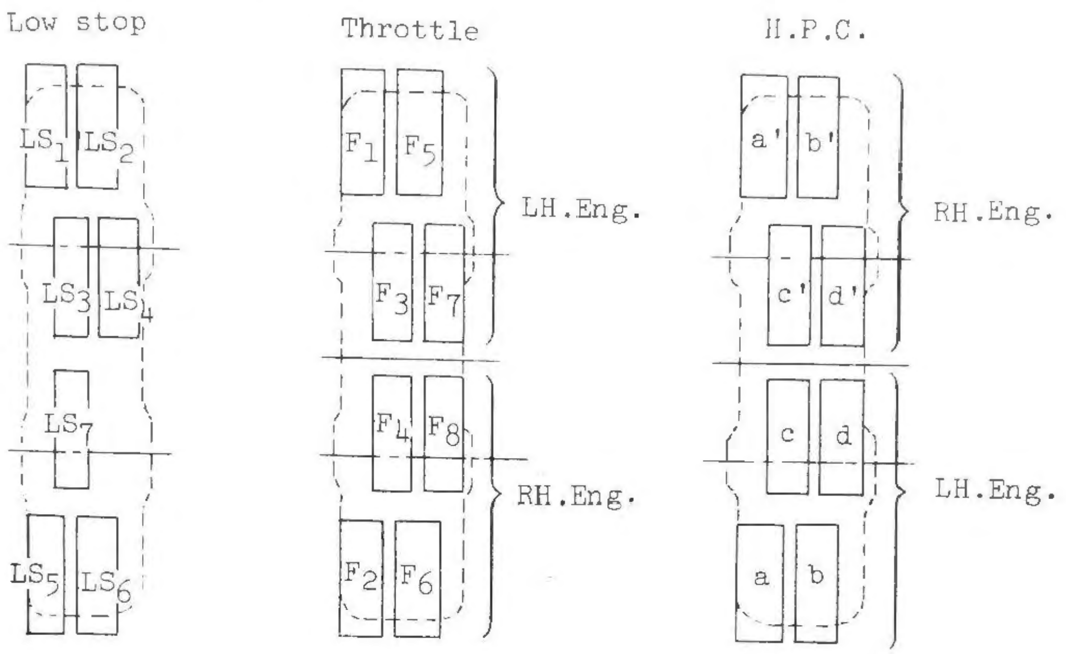
c. No. 2 throttle lever is placed in a lever position above 12,000 rpm and,

d. R.H. H.P.C. lever is placed in the fuel on or high stop withdrawal position.

Under the above conditions, the propeller is feathered if the auto coarsening relay is energized.

When the H.P.C. lever is in the OFF or feather position, the switch b closes the W/M shut-off valve. Therefore, W/M can not be supplied even if W/M injection is tried.

The switch d in the propeller brake system, permits power from the D.C. emergency bus to flow to the propeller brake switch when the H.P.C. lever is in the fuel off position. Then, the brake can be applied to the propeller.



Micro Switch Groups on Pedestal

Low Stop Lever Switch

Switch Symbols		Low Stop Lever Position		System Involved	Control System
L.H.Eng	R.H.Eng	Ground	Flight		
LS_2	LS_1	Open	Close	Flight Fine Pitch Elect - Hyd. Stop (Pitch Coarsening Solenoid)	Propeller Control
LS_3	LS_4	Close	Open	Low Stop Withdrawal Solenoid	Propeller Control
LS_5	LS_7	Close	Open	Voltage Change Over Switch 150V ⟶ 204V	Elect. System Wild Frequency Power Source
LS_6		Close	Open	Spill takes place below 380 lb/hr of fuel flow in the ground position	Air Conditioning Spill

Throttle Lever Switch

Switch Symbols		Lever Position			Requirements for Switch Change-over Point	
L.H.Eng.	R.H.Eng	Min.	Change-over point	Max.	Requirements for Operation	Requirements shown in terms of throttle lever angle of F.C.U.
F_1	F_2	Close	0	Open	Fuel Flow 700 ± 20 lb/hr	15°44' ~ 17°10' Warning for landing gear
F_3		Open	0	Close	Engine Speed 12,800~13,000rpm	28°30' ~ 30°30' (Low Torque Switch)
	F_4	Open	0	Close		
F_5	F_6	Close	0	Open	Fuel Flow 380 ± 20 lb/hr	4°18' ~ 5°46' Air conditioning spill valve shut
F_7		Open	0	Close	Engine Speed 14,750~14,950rpm	48°40'~51°50' Air conditioning spill valve open
	F8	Open	0	Close		

H.P.C. Lever Switch

Switch Symbols		Lever Position				Control System
L.H.Eng.	R.H.Eng.	High Stop Withdrawal	Fuel ON	Fuel OFF	Feather	
a	a'	Close	Close	Close	Open	Prop. Control Auto Coarsening Circuit
b	b'	Close	Close	Open	Open	Prop. Control W/M Act. Relay
c		Open	Open	Open	Close	Prop. Control Automatic Coarsening
	c'	Open	Open	Open	Close	
d		Open	Open	Close	Close	Stair Way Circuit

4.8.5 Throttle Control System (Figs. 4-26 and 27)

(1) General

The throttle control system controls engine fuel flow and selects the engine speed with a single lever and it also controls W/M injection. The linkage on the aircraft side transmits the throttle lever action over its entire range to the engine control box throttle pick up lever exactly. On the L.H. nacelle is provided the corrector unit of the propeller synchronizer system.

(2) Composition of System and Summary of Components

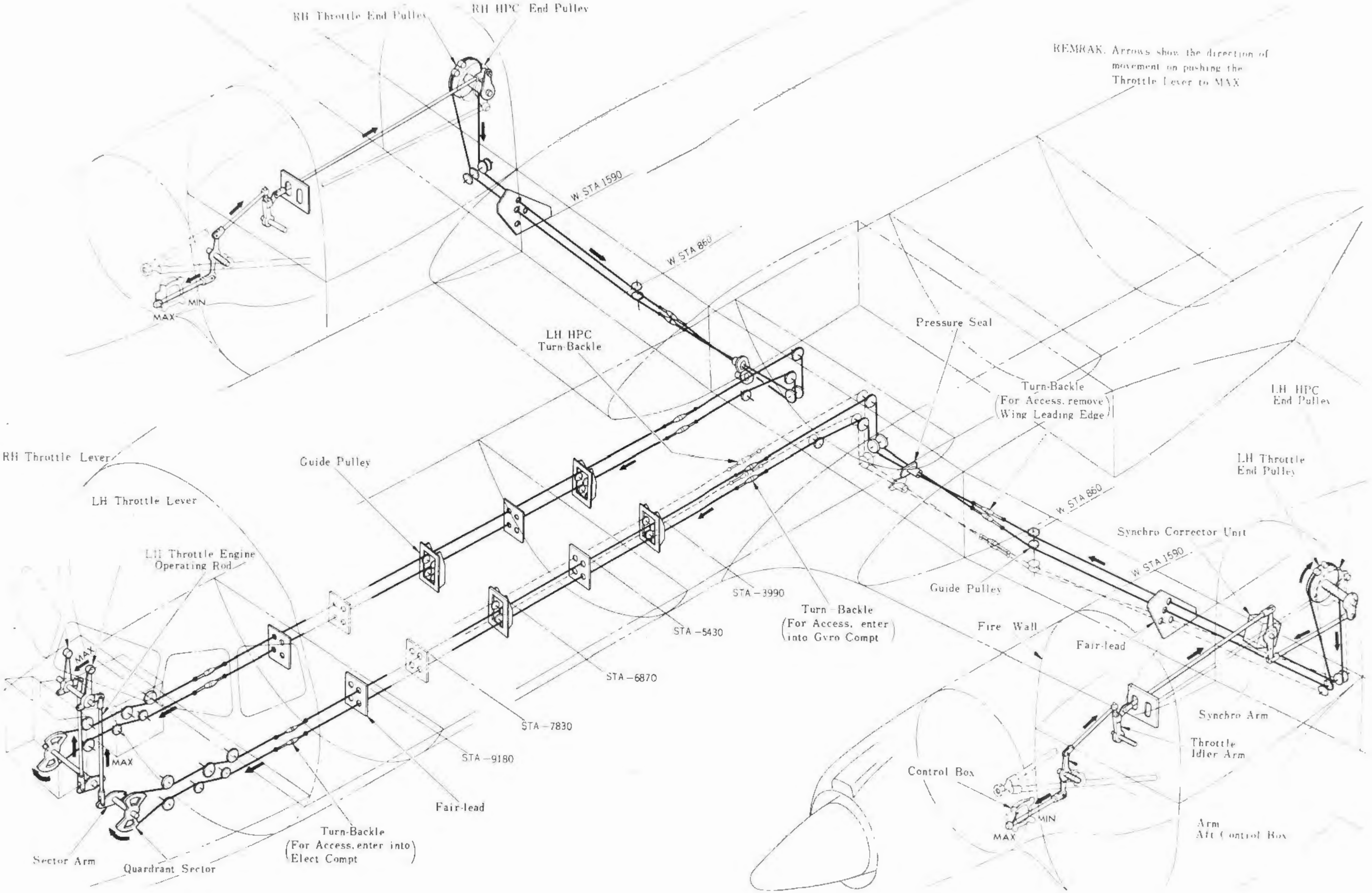
The components move in the following sequence:
Lever → Rod → Torque Tube → Sector → Cable → Control Rod → Engine Pick up Lever.

A cable is used between the quadrant sector in the center pedestal and the quadrant in the nacelle. The nacell quadrant and the engine pickup lever are connected with rods.

Three turnbuckles are used in the cable. At the fuselage--wing joint is used a pressure seal on which MIL-G-7187, grease is applied.

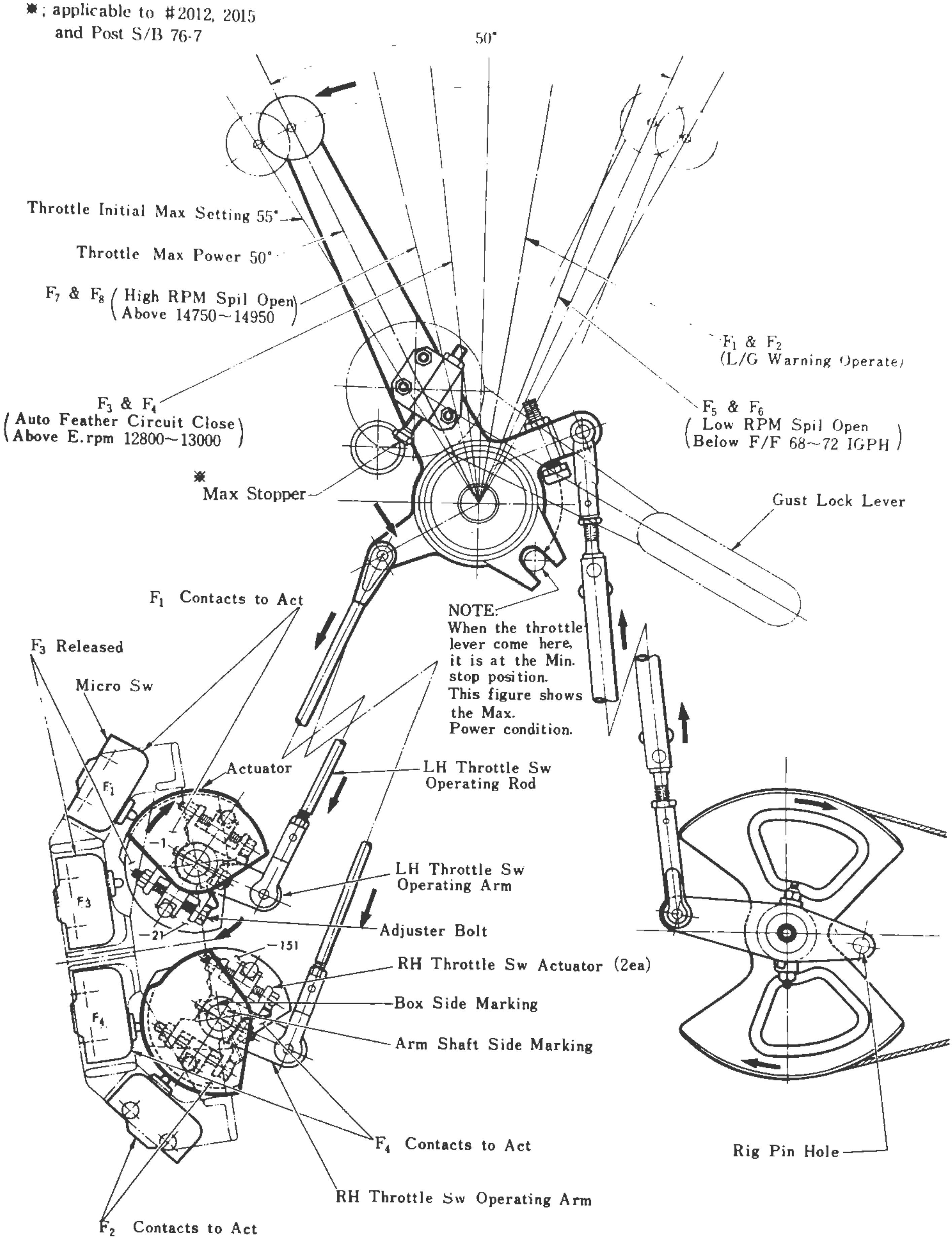
At the nacelle quadrant is provided a friction damper with which the throttle lever can be maintained at a given position.
The torque of the friction damper is so adjusted that the throttle lever can start moving at 35 to 40 in.lb.

On the left hand side is installed the synchronizer corrector motor. The synchro arm rotates around the eccentric shaft of the corrector unit.



Throttle Lever Control System General View

Figure 4-26



Operating Point of Throttle Lever
Figure 4-27

When the synchronizer system is turned off, the synchro arm only relays the motion of the push pull rod. When the throttle is to be rigged, it is necessary to set it to the datum line with a special tool installed. Otherwise, the datum position can not be determined.

(3) Requirements of Throttle Operation

When both throttle levers in the cockpit are advanced fully together, the throttle pickup levers in the engine control box must come in contact positively with the max. stoppers on the control box side. Likewise, they must come in contact positively with the min. stoppers when the levers are retarded fully.

(4) Propeller Synchronizer

A. Summary

The propeller synchronizer is provided to synchronize the L.H. and R.H. engines, reducing vibrations to the aircraft, discomfort to crew and passengers, noises etc. due to the speed difference of both engines and relieving the pilots from incessant burden of engine control.

The R.H. engine serves as the master engine. Consequently, the R.H. engine is not affected by this unit, the L.H. engine being the slave engine. That is to say, the speed of the L.H. engine is maintained equal to that of the R.H. engine by means of the synchronizer control unit.

B. Mechanism

On the gear boxes of the L.H. and R.H. engines are installed the synchronizer alternators. On the L.H. engine is provided a corrector motor connected to the engine power control linkage.

Signals corresponding to the difference of speeds of the L.H. and R.H. alternators are sent to the corrector motor which regulates the engine fuel flow and the propeller control unit.

Actually, the throttle linkage moves the engine control system by means of the friction damper, not by moving the throttle lever by means of the corrector motor.

Do not move the throttle abruptly lest the datum setting of the synchronizer motor should go wrong.

C. Operation

This unit can be operated by turning on the synchronizer switch in the cockpit.

The maximum adjustable range of speed is approximately ± 250 rpm due to structural characteristics of the synchronizer unit which is effective only when the throttle is in the constant speed range of 11,000 to 15,000 rpm.

If the engine speed correction is desired or any unstable condition is noticed while the synchronizer is in use, turn off the synchronizer once and turn it on after readjusting the throttle.

When the throttle is placed at the min. constant r.p.m., the engine speed depends on the P.C.U. only and the synchronizer does not work.

During climb and cruising, the unit has tolerances of + 100 rpm for a desired mean speed (average of the L.H. and R.H. engine speeds).

Turn off the synchronizer switch during take-off and landing. Otherwise, the speed of the slave engine will be affected if the master engine failed.

4.8.6 Fuel Trim Control System

(1) General (Figs. 4-28 and 29)

The rise of the outside air temperature decreases the engine intake air mass flow at any engine speed.

If the fuel flow remains unchanged under such circumstances, the mixture ratio becomes too rich, elevating the turbine temperature excessively. Therefore, the fuel flow must be reduced as the ambient temperature increases. For this purpose is provided the trimmer. The trimmer does not change the engine speed but changes the fuel flow only. This can be accomplished by restricting the throttle valve opening of the F.C.U. with the trimmer.

(2) Summary of Operation

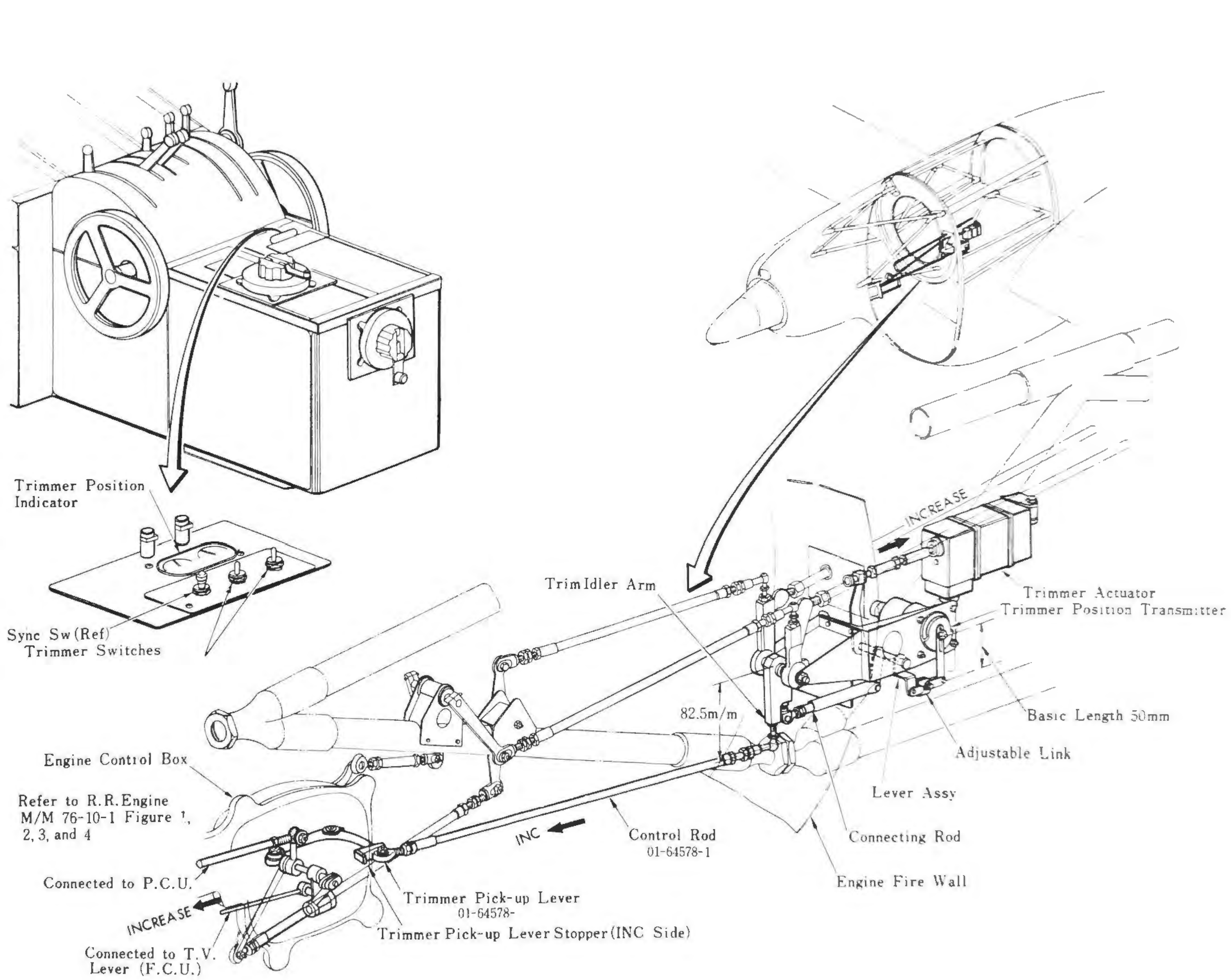
If the trimmer switch on the pedestal is turned to INC or DEC, the trimmer actuator on the engine side rotates while the switch is being depressed. The motor moves the plunger rectilinearly which is connected to a rod actuating the engine trimmer pickup lever.

(a) Structure of Trimmer Actuator

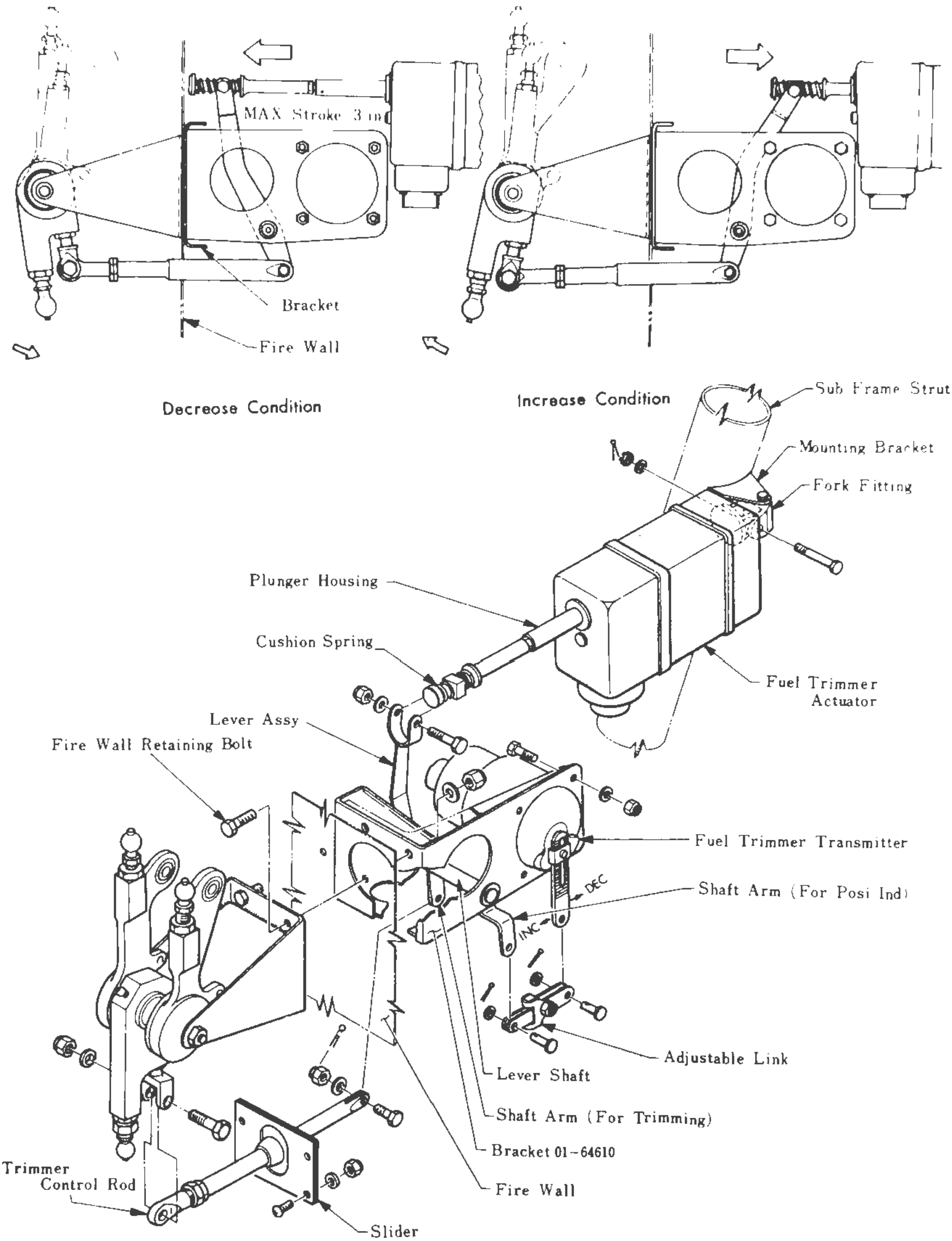
Inside the actuator is located a motor operating on 22 to 28 V DC. The motor rotation moves the screw jack rectilinearly through the reduction gears. The screw jack is located in the plunger housing, its rectilinear motion being the plunger stroke. The stroke is 3 in. at the maximum. Inside the actuator are provided two limit switches which stop the motor automatically if the plunger reaches its extreme ends. On the ends of the plunger are installed shock absorbing fittings with cushion springs to avoid damage to the actuator.

(b) Trimmer Position Transmitter (Fig. 4-30)

If the trimmer actuator moves, its actuating lever swings to the left and to the right. The lever, in turn, swings the sector gear plate to the left and to the right. Then, the pinion gear rotates. The arm rotates the turning assembly with the pin coupling.

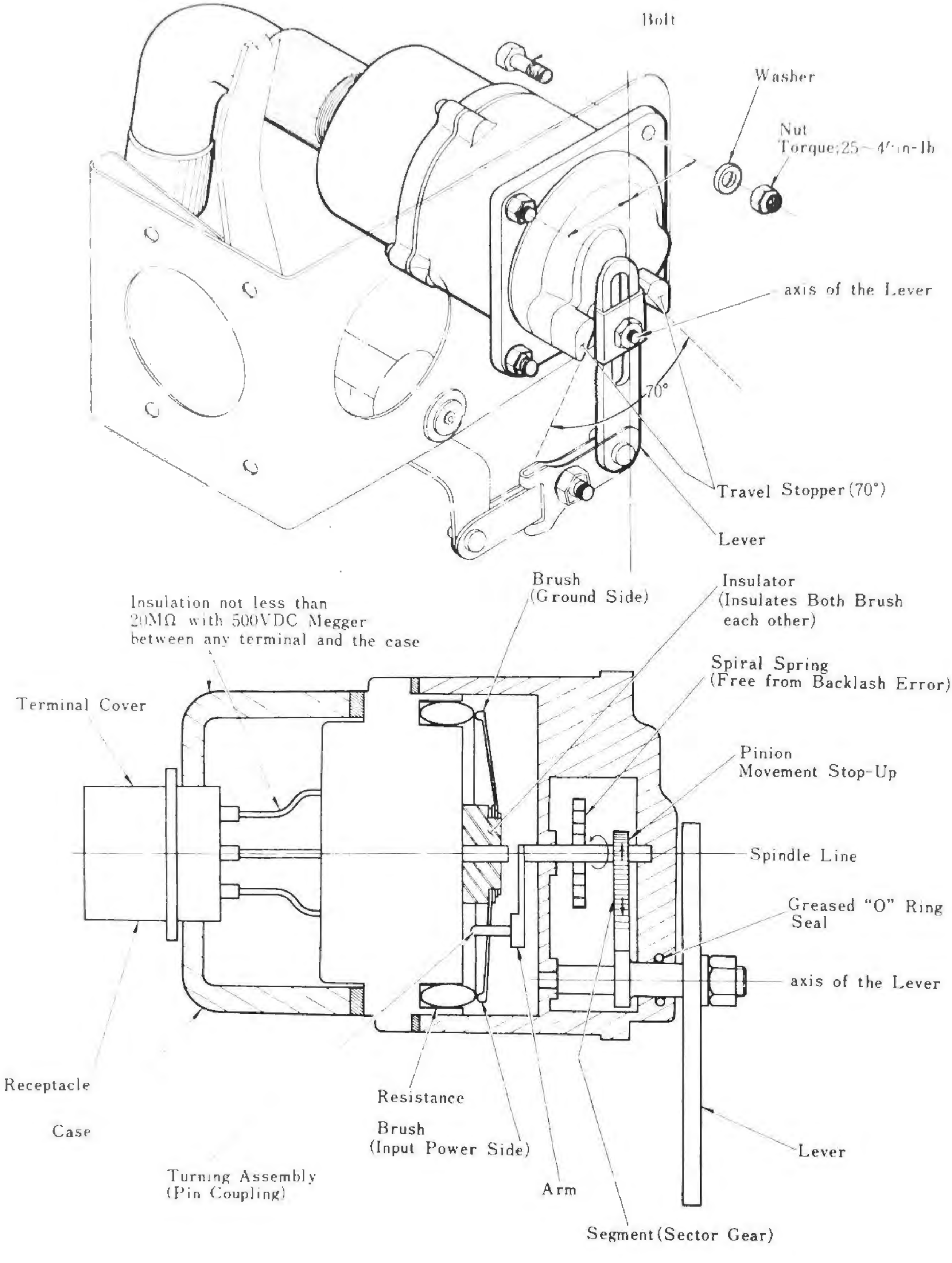


Fuel Trimmer Control System General View
Figure 4-28



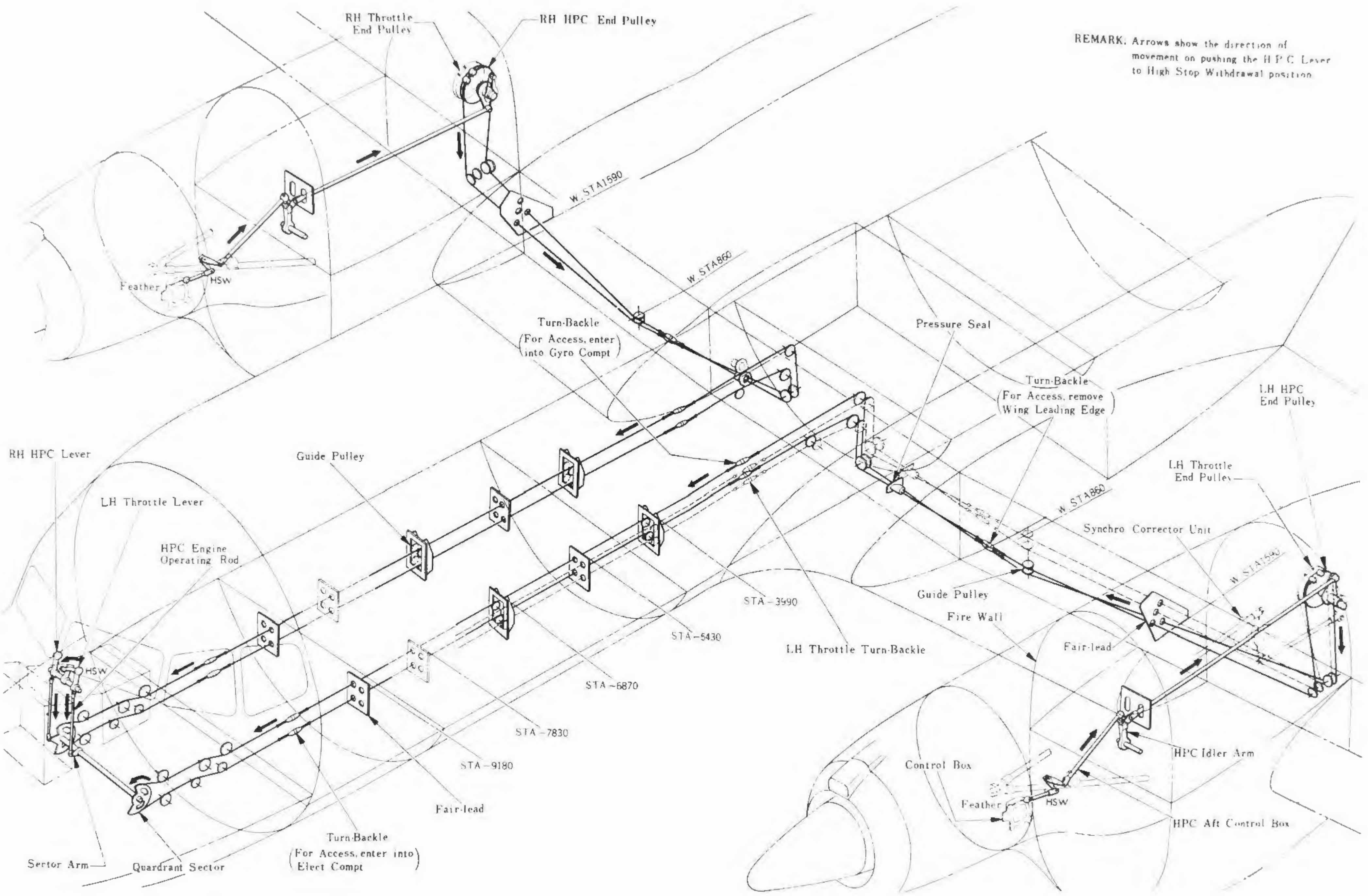
Fuel Trimmer Actuator & Transmitter

Figure 4-29



Fuel Trimmer Position Transmitte

Figure 4-30



HPC Lever Control System General View

. Figure 4-31

4.8.7 H.P.C. Control System

(1) General

H.P.C. stands for the high pressure cock. This permits or shuts off the high pressure fuel supply to the engine fuel manifold located in the fuel control unit. This is manually controlled by a lever in the cockpit.

When the H.P.C. lever is located in the high stop withdrawal position, a mechanical circuit which withdraws the high stop is made manually by the feathering selector lever of the propeller control unit. If the electrical circuit is energized at the same time, the feathering motor rotates to feather the propeller.

This lever has the following four positions on the pedestal:

$$
\text{4 positions} \left\{ \begin{array}{ll} \text{High Stop Withdrawal} & \text{Position} \\ \text{Fuel ON} & \text{"} \\ \text{Fuel OFF} & \text{"} \\ \text{Feather} & \text{"} \end{array} \right.
$$

The micro switch on the switch panel of the pedestal actuates the lever arm mechanically, depending on the lever positions.

(2) Composition of System (Fig. 4-31)

The system is actuated in the following sequence:

Lever → Lever Arm → Operating Rod → Sector → Cable → Control Rod → Engine H.P. Cock & Feathering Pickup Lever.

The quadrant sector of the center pedestal and the nacelle quadrant are connected with a cable in which are used three turnbuckles. The nacelle quadrant and the engine H.P. Cock & feathering pickup lever are connected with rods.

At the fuselage -- wing joint is used a pressure seal.

(3) Operation of H.P. Cock Lever

The normal position of the lever when the aircraft is stationary on the ground is "Fuel OFF."
As soon as the engine speed reaches 1200 to 1500 rpm at the engine starting, the lever must be moved to the high stop withdrawal at once.
If the starting failed within 30 sec., move the lever to "Fuel OFF" and place the start selector switch in "Safe."

4.8.8 Adjustment/Check of Power Plant Control System

(1) Adjustment of Throttle Control System

Tools for adjustment to be prepared

a. 01-96214
b. 01-96075-11, 01-96230-11, -21 and -60
c. 20 lb spring balance
d. Cable tension meter

A. Adjust the engine control linkage properly in accordance with the engine maintenance manual, M-Da10-YS.

B. Adjustment Zones

The throttle control system is divided into the following four zones: If adjustment of one part does not affect the others, readjustment of other parts is not necessary.

(A) Throttle lever -- quadrant sector below the pedestal

(B) Quadrant sector below the pedestal -- upper quadrant pulley on the spar on the forward side of the fire wall

(C) Upper quadrant pulley on the spar on the forward side of the fire wall -- idler lever on the forward side of the fire wall

(D) Idler lever on the forward side of the fire wall -- engine control box

C. Adjustment of Throttle Lever -- Quadrant Sector below Pedestal

NOTE: While the adjustment is made, keep the idler arm of the control rod joint disconnected from the rod.

(A) Disengage the gust lock, advance the throttle levers together and place the gust lock stopper in close contact with the low stop hook. Protrude the max stop bolt until it touches the low stop shaft. Retard the throttle slightly and protrude the stop bolt a little by rotating it by 1/4 turn.

Make sure that the mark on the side of the throttle lever is located slightly ahead of the blue mark (Fig. 4-20) on the disc in case of Fig. 4-23, A.

(B) Place the throttle torque tube below the pedestal in the max. position, adjust the length of the rod assembly connected to the throttle lever torque tube and tighten the check nut so that the rig pin, 01-96075-11 can be inserted into the throttle sector arm side rigging hole of the arm and the rig pin hole of the structure and be fixed and the mark on the side of the throttle lever can be brought in line with the red mark on the disc. (The position of the throttle lever is 5° before the position described in 8 (1) C (A).)

(C) After confirming that the requirement of 8 (1) C (A) is met by moving the throttle lever a few times, paint marking on the check nut of the rod assembly(this indicates slip and color and marking method are discretionary.).

(D) Holding the throttle lever in such a position that the mark on the side of the throttle lever is brought in line with the white mark on the disc, adjust the length of the throttle switch operating rod (Fig. 4-23) until the mark on the side of the box side marking of the throttle micro switch box is brought in line (Fig. 4-18), and, then tighten the check nut.

D. Adjustment of Quadrant Sector below the Pedestal -- Upper Quadrant Pulley on Forward Spar of Nacelle

(A) Insert the rig pin, 01-96075-11 into the arm of the throttle torque tube below the pedestal and the rig pin hole of the structure and fix it at the max. position.

(B) Insert the rig pin, 01-96230-11 into the upper quadrant pulley on the forward spar of the nacelle and the rig pin hole of the pulley bracket and fix it at the max. position (Fig. 4-32).

(C) Adjust the cable tension between the sector below the pedestal and the end pulley to the value as shown in Fig. 4-34.

(D) Remove the rig pin fixing the end pulley, make sure that both cable tensions are well balanced and put safety wire on the turnbuckles. Later, remove the rig pin fixing the sector located below the pedestal.

E. Adjustment of Upper Quadrant Pulley on Forward Spar of Nacelle

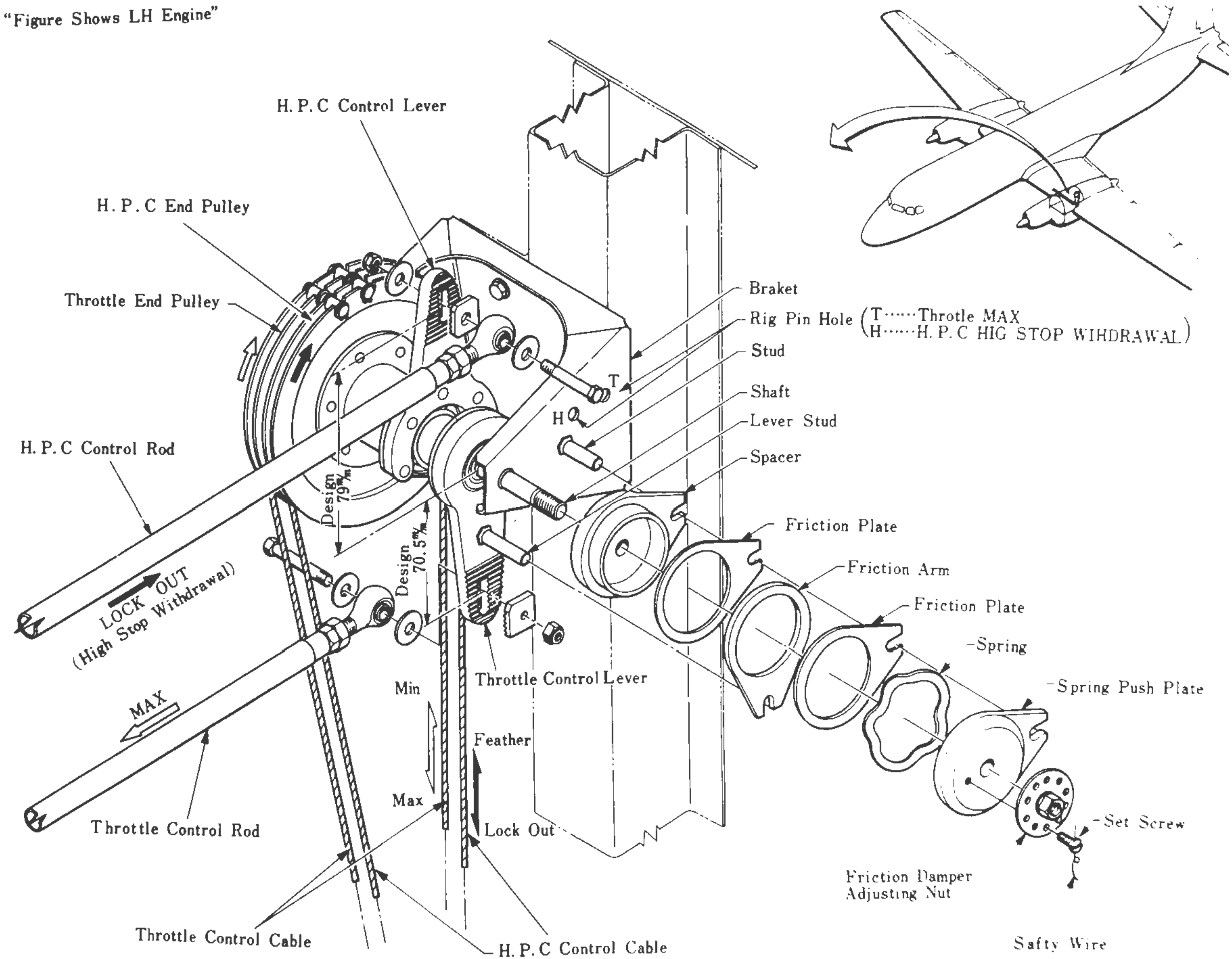
(A) Fix the end pulley at the max. position with a rig pin.

(B) Set the locking plate, 01-96214 on the propeller synchro corrector motor (SNC/22) and set the slot on the eccentric shaft of the corrector motor.

NOTE: The instruction of this sub-paragraph is applicable to the L.H. side only.

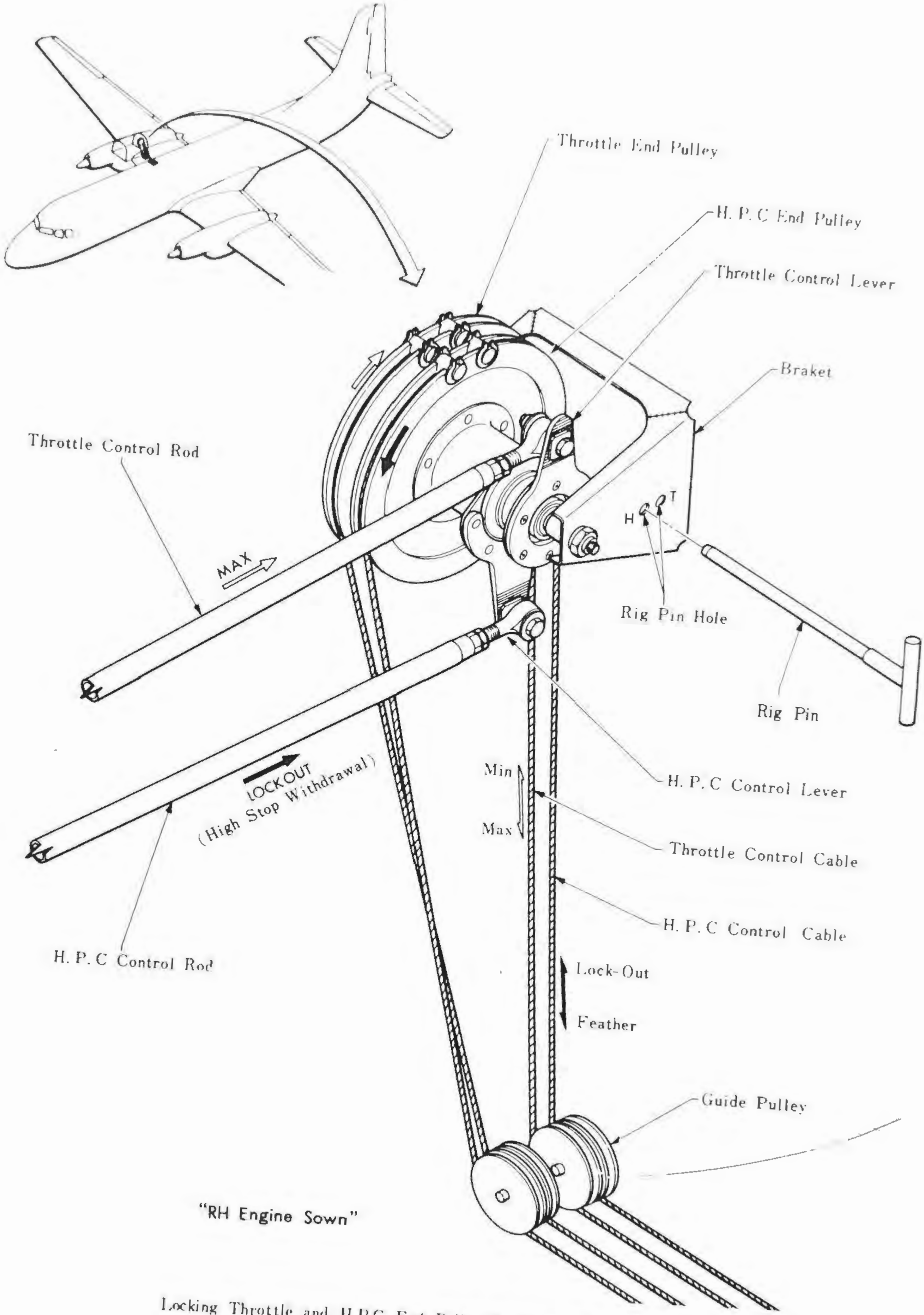
(C) Adjust the arm length of the end pulley to the design value (69.5 m/m) and adjust the length of the throttle control lever so that the propeller synchro arm assembly can be fixed, inserting the rig pin, 01-96230-21 into the rig pin hole of the propeller synchro arm and the rig pin hole of the corrector motor mounting pad assembly, and, then, tighten the check nut (Figs. 4-32 and 4-35).

NOTE: This instruction is applicable to the L.H. side only.

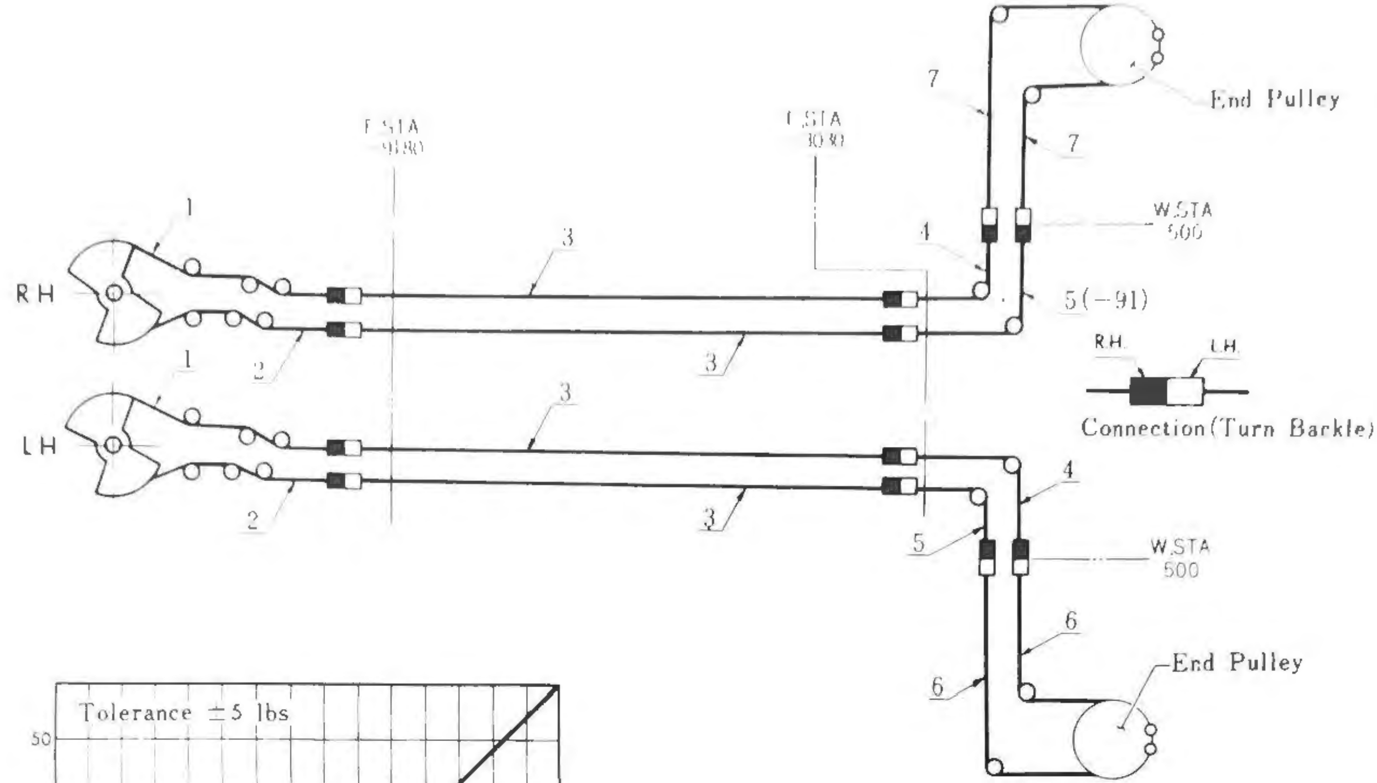


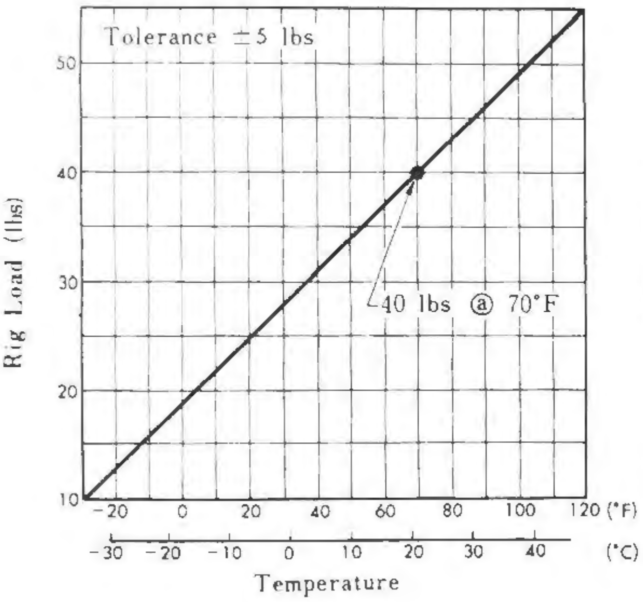
Locking Thrattle and H.P.C End Pully OF Quardrant in LH Nacelle

Figure 4–32



Locking Throttle and H.P.C End Pully OF Quardrant in RH Nacelle
Figure 4-33

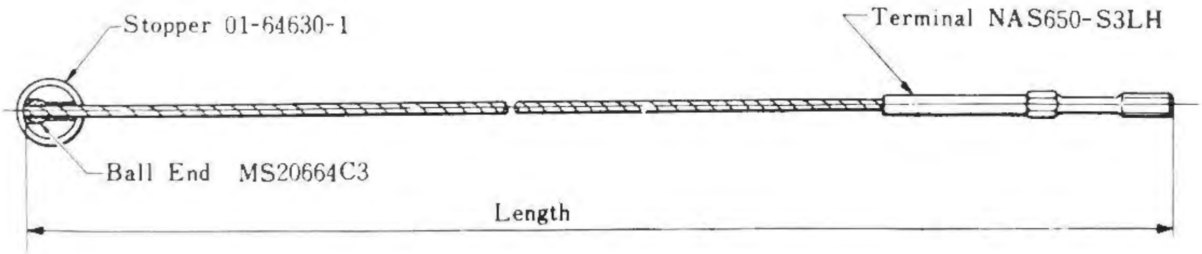




Initial Cable Tension

	Cable Assy Parts Number	Fitting		Length mm
1	01-64210-61	AN664-3	AN669L3RH	1,367
2	01-64210-71	AN664-3		1,390
3	01-64209-51	AN669L3LH		6.400
4	01-64209-61			2,597
5	01-64209-71	AN669L3LH	AN669L3RH	2,512
*6	01-64629-11	See Detail A		3,400
*7	01-64629-21	See Detail A		2,700

Note: As shown in detail A, the stopper 01-64630-1 shall be attached to one end of cable assembly marked with*



Detail A

Cable Chart (Throttle)
Figure 4-34

(D) Insert the rig pin 01-96230-61 into the rig pin holes of the throttle idler arm and the idler bracket on the forward side of the fire wall and adjust the length of the throttle rod so that the idler lever arm can be fixed at the max. position. And, then, tighten the check nut (Fig. 4-37).

NOTE: This instruction is applicable to the L.H. side only.

(E) Insert the rig pin, 01-96230-61 into the rig pin holes of the throttle idler arm assembly and the bracket assembly on the forward side of the fire wall, set the length of the arm of the end pulley to the design value of 61.0 mm and adjust the length of the throttle control rod so that the idler lever arm can be fixed at the max. position. And, then, tighten the check nut (Fig. 4-33).

NOTE: This instruction is applicable to the R.H. side only.

F. Adjustment of Idler Lever -- Engine Control Box on Forward Side of Fire Wall

(A) Set the length of the connecting arm for the throttle idler arm and the ball end on the forward side of the fire wall to the design value of 125.0 mm and, then, tighten the check nut (Fig. 4-40).

NOTE: Adjust the position of the indicator plate of the throttle idler arm so that its pointer is brought in line with the max. position.

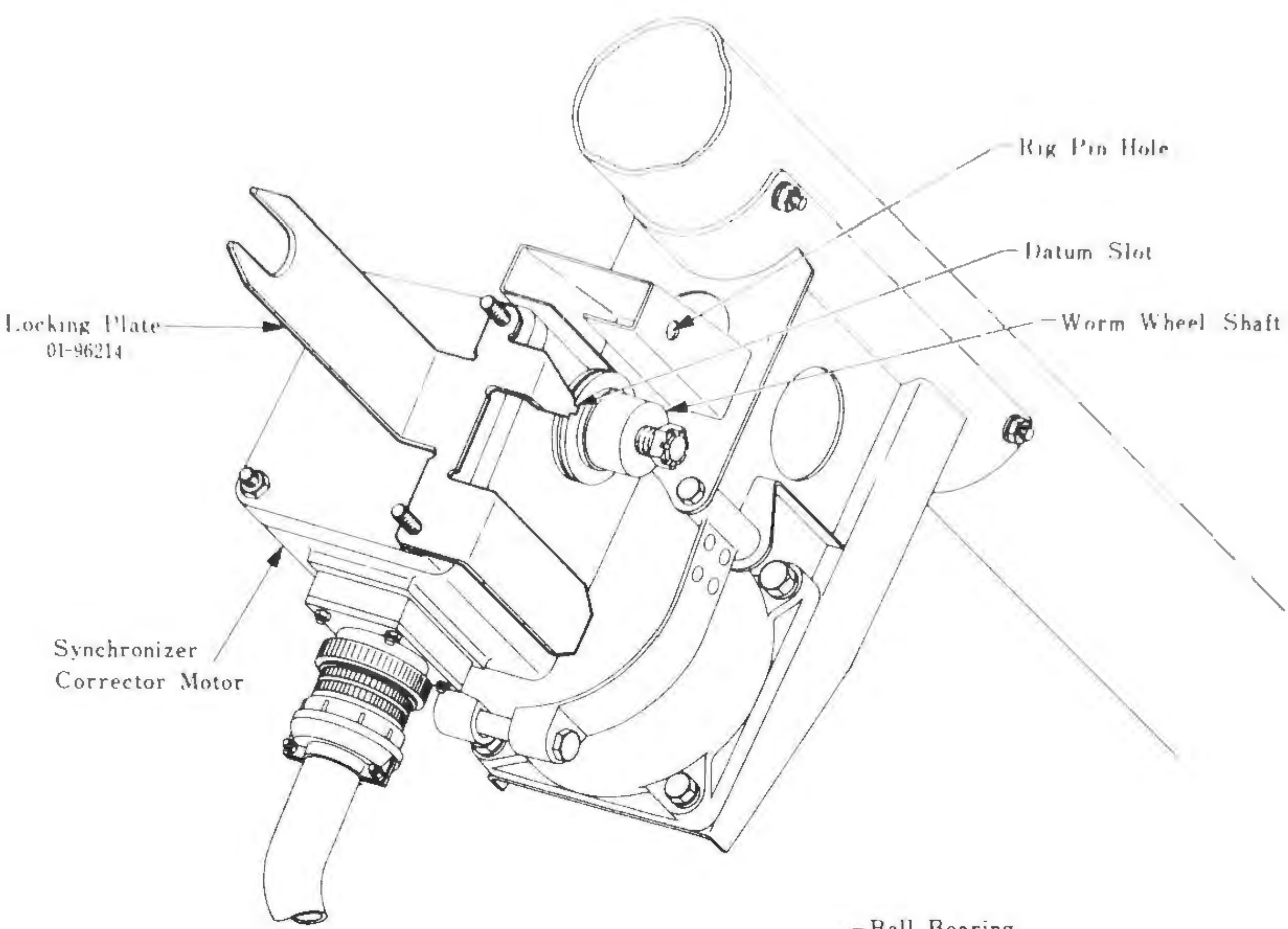
(B) Adjust the length of the throttle rod connecting the idler arm on the forward side of the fire wall and the arm located before the engine control box, and connect the arm located before the engine control box and the engine control box pickup lever to place them in positive contact with the max. stopper of the engine control box. Accomplish adjustment so that the center line of the throttle arm is brought in line approximately with the center line of the supporting point of the arm bracket.

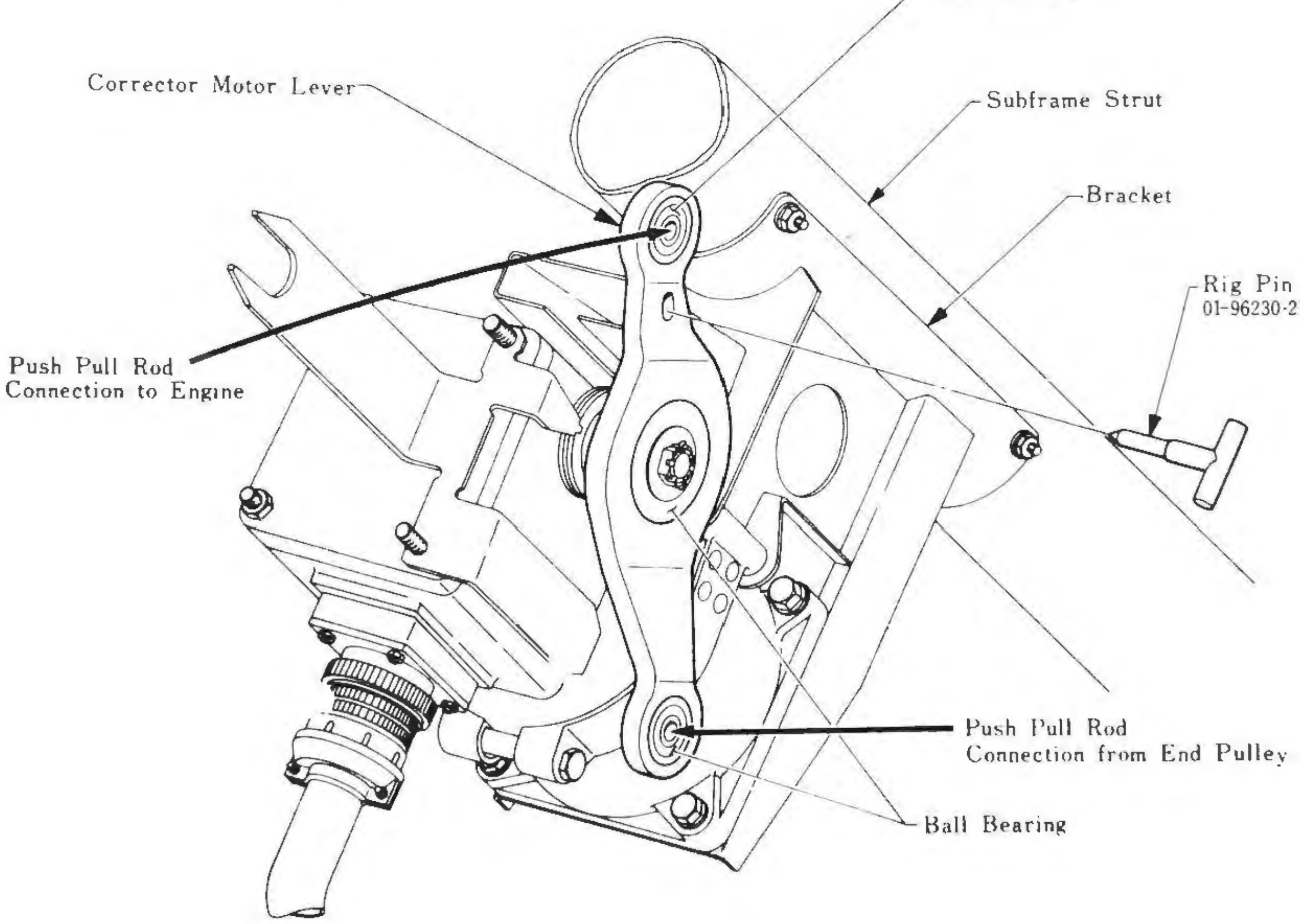
(C) Remove all the rig pins and operate the throttle lever so that the engine pickup lever is in contact with the min. stopper of the engine control box. Make sure that the gap between the adjustable bolt installed on the throttle lever on the pedestal and the stopper is 3.5 mm.
It is desirable that under the above mentioned conditions, the mark on the side of the throttle lever is lined up with the white mark on the disc (Fig. 4-20).

NOTE: Accomplish adjustment so that the position of the min. indicator plate of the firewall idler lever is lined up with the pointer when the engine pickup lever is in contact with the min. stopper of the engine control box.

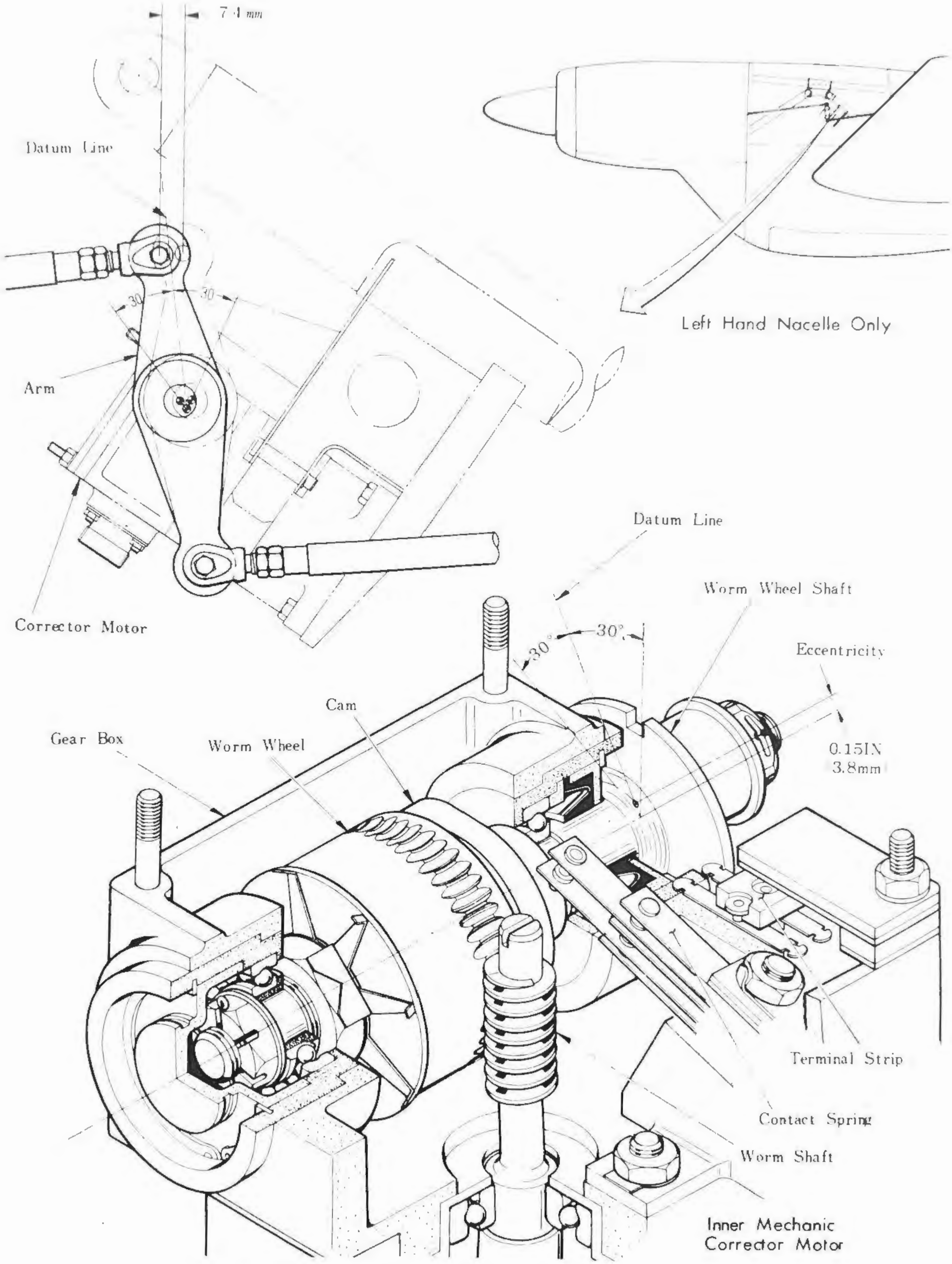
(D) Adjustment of Friction Damper

NOTE: This instruction is applicable to the L.H. side only.



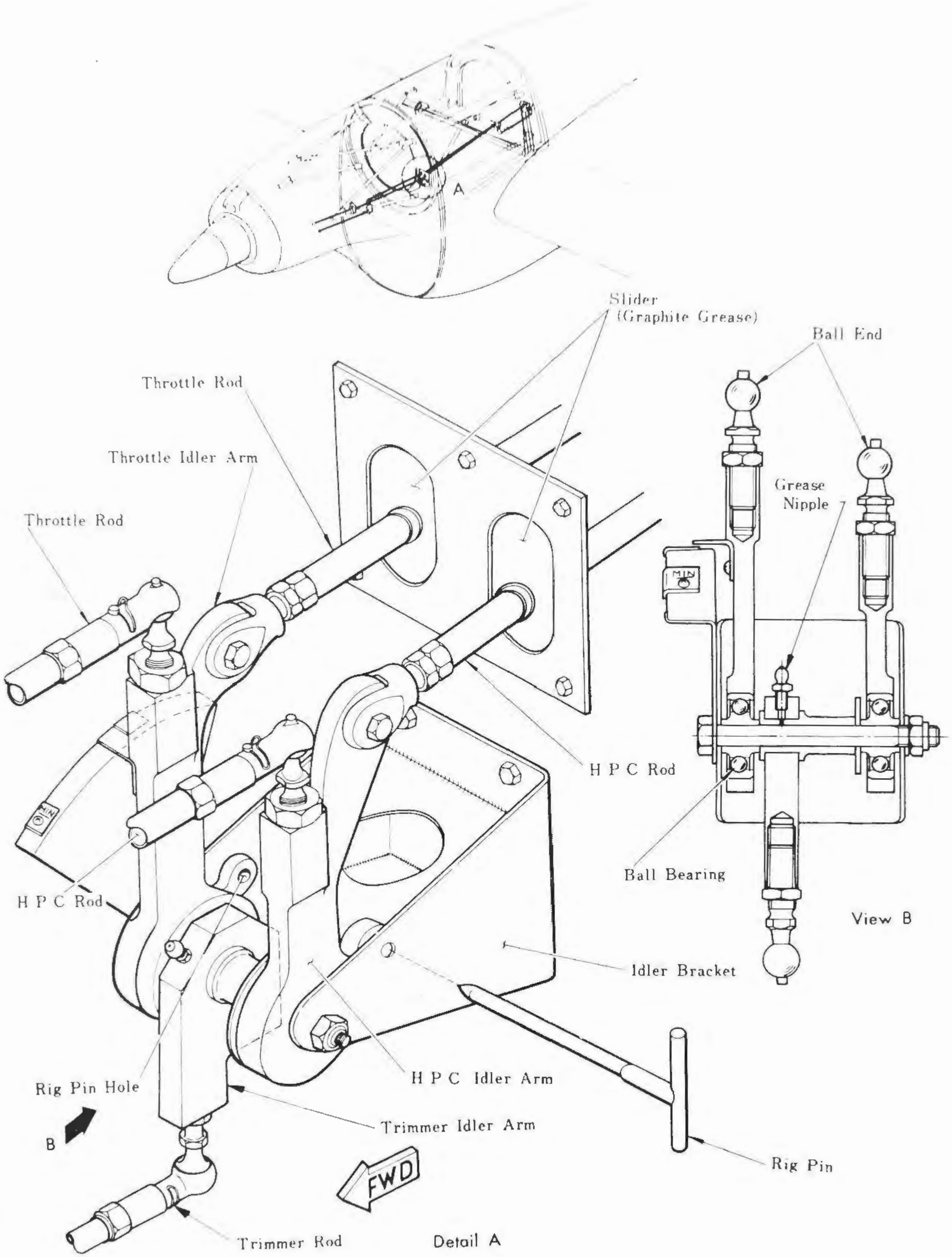


Locking-Synchronizer Corrector Motor
Figure 4-35



Inner Mechanism of Synchronizer Corrector Motor and Opereation Diagram

Figure 4-36



Idler Lever Assembly on Fire wall

Figure 4-37

a. Disconnect the joint of the throttle control rod connected to the corrector motor arm and the throttle control lever.

b. Tighten the friction damper adjusting nut so that the end pulley arm begins to move at the torque value of 30 to 45 in.lb. (Fig. 4-32).

(E) Make sure that the throttle can be fixed at the max. position, that the mark on the side of the throttle lever is lined up with the red mark of the disc and that the mark pointer of the idler lever on the engine fire wall indicates the max. position of the throttle position indicator.

(F) Check the control force of the throttle lever at the following points, make sure that it is less than 7.5 lb and record the control force measured.

NOTE: During this operation, maintain the low stop lever in the flight position.

a. Advance the throttle lever further ahead of the position in which the mark on the side of the throttle lever is lined up with the red mark on the disc to align the side mark to the blue mark on the disc. The control force must be 200 to 250 % of the "PUSH" control force mentioned in 8(1) F(F).

b. Retard the throttle lever until it hits the adjusting bolt stopper 3.5mm away from the throttle lever when it is in contact with the engine side min. stopper. Then, the control force must be 200 to 250 % of "PULL" control force described in 8(1) F(F).

NOTE: Make sure that no check nut is loose.

(2) Adjustment of H.P.C. Control System

Tools to be prepared.

(a) Rig pin, 01-96075-1, 01-96230-11 and -61

(b) Cable tension meter

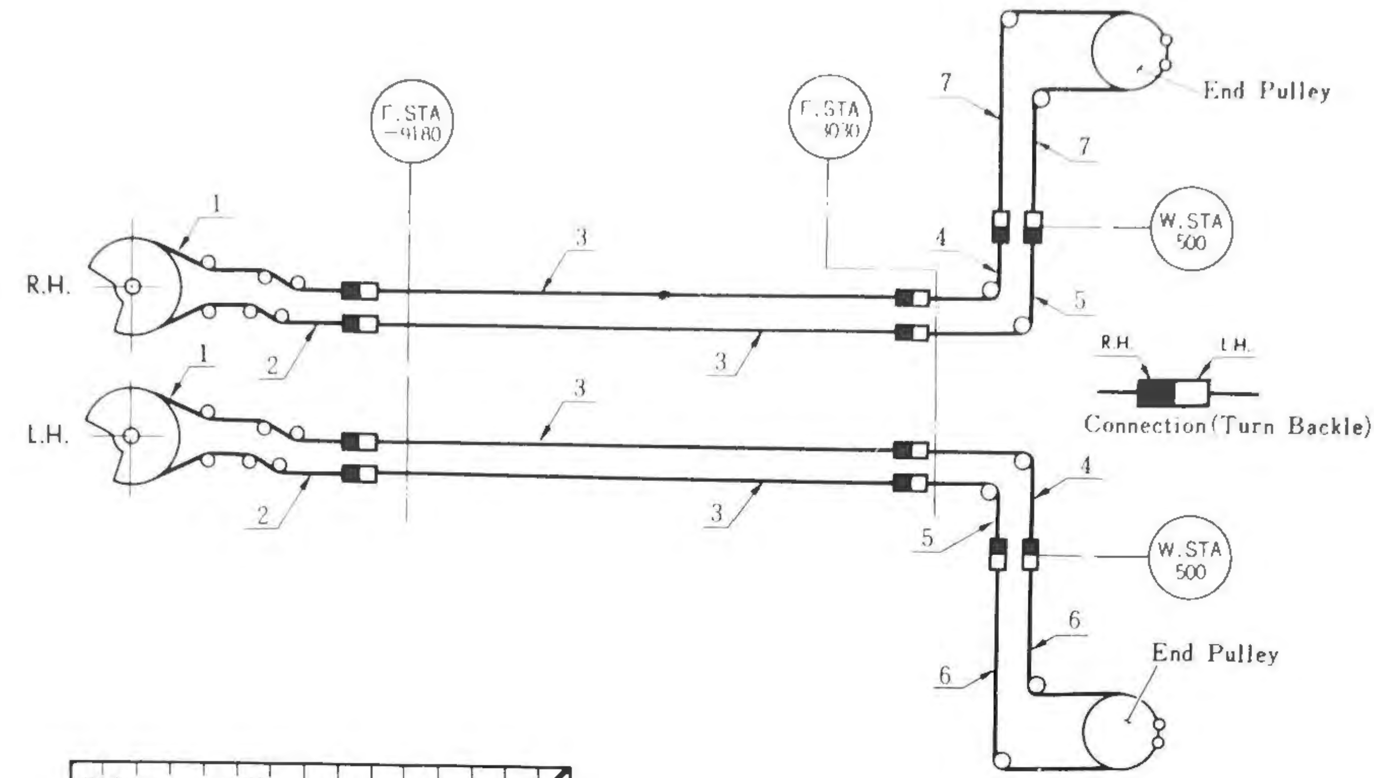
A. Adjustment of H.P.C. Lever -- Quadrant Sector below Pedestal

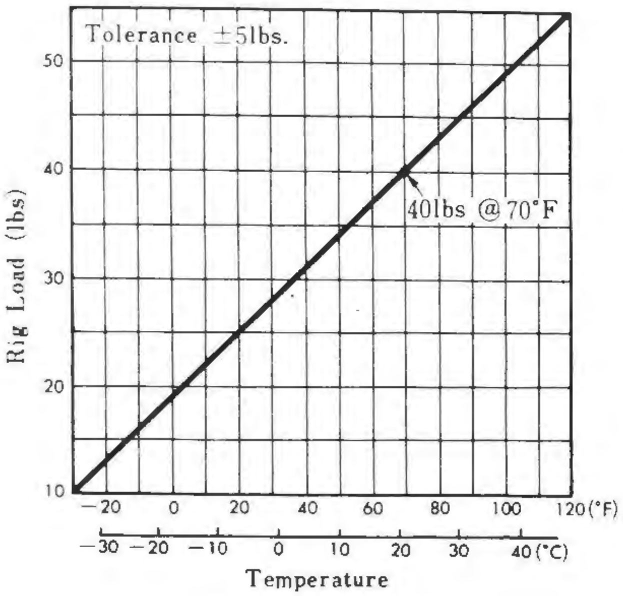
(A) Place the H.P.C. lever in the high stop withdrawal position.

(B) Insert the rig pin, 01-96075-1 into the rig pin hole of the arm or the sector so that the H.P.C. torque tube below the pedestal or the sector is placed in the high stop withdrawal position to fix the sector.

a. Adjust the length of the H.P.C. operating rod so that the conditions of 8(2) A (A) and (B) are attained simultaneously.

b. Rotate the rod assembly adjusted in 8(2) A(a) by 0.6 turns, tighten the check nut fixing the rod end and paint marking

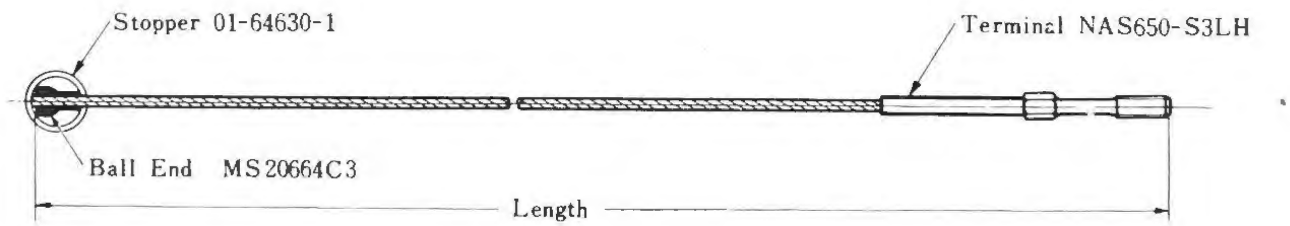




Initial Cable Tension

	Cable Assy Parts Number	Fittings		Length mm
1	01-64210-81	AN664-3	AN669L3RH	1,238
2	01-64210-91	AN664-3	↕	1,254
3	01-64209-51	AN669L3LH		6,400
4	01-64209-81	↕		2,714
5	01-64209-91	AN669L3LH	AN669L3RH	2,629
*6	01-64629-11	See Detail A		3,400
*7	01-64629-21	See Detail A		2,700

Note: As shown in detail A, the stopper 01-64630-1 shall be attached to one end of cable assembly marked with *



Detail A

Cable Chart (H.P.C.)
Figure 4-38

on the check nut. (This indicates slipping. Color and marking method are discretionary).

c. Remove the rig pin, pull the H.P.C. lever, adjust the lengths of the switch rod and the rod end so that the side mark of the H.P.C. switch box is lined up while the lever guide pin is in the rear groove of the high pressure guide and, then, tighten the check nut.

d. Move the H.P.C. lever several times to make sure that the requirement of 8(2) A(c) is satisfied and paint mark on the check nut of the switch rod. Make sure that the rod assembly is normal by checking the mark painted in 8(2) A(b).

B. Adjustment of Quadrant Sector below Pedestal -- Nacelle Quadrant Pulley (Fig. 4-22)

NOTE: During the operation mentioned here, any connection of the control tube in the nacelle must be kept disconnected.

(A) Fix the torque tube assembly below the pedestal or the sector assembly in the high stop withdrawal position with a rig pin.

(B) Fix the upper quadrant pulley on the forward spar in the nacelle in the high stop withdrawal position with the rig pin, 01-96230-11.

(C) Adjust the tension of the cable between the sector below the pedestal and the end pulley to the value shown in Fig. 4-38.

(D) Remove the rig pin fixing the end pulley, make sure that the tensions of both cables are uniform and lock the turnbuckles with safety wire. Then, remove the rig pin fixing the sector below the pedestal.

C. Adjustment of End Pulley -- Engine Control Box

(A) Disconnect one end of the control rod connected to the lever assembly located before the engine control box.

(B) Fix the end pulley in the high stop withdrawal position with a rig pin.

(C) Adjust the lengths of the H.P.C. control rod and the H.P.C. control lever which connect the idler arm in front of the fire wall and the end pulley so that the idler arm can be fixed in the high stop withdrawal position with the rig pin, 01-96230-61 and that the length of the arm connected to the end pulley can be equal to the design value 79.0m/m. And, then, tighten the check nut. (L.H. Fig. 4-32)

NOTE: The procedures described here are applicable to the L.H. as well as to the R.H.
For R.H. see Fig. 4-34.

(D) Adjust the length of the arm connecting the idler arm in front of the fire wall and the ball end to the design value of 166.5 m/m and tighten the check nut. (Fig. 4-39)

(E) Fix the idler arm in front of the fire wall in the high stop withdrawal position with a rig pin.

(F) Adjust the lengths of the idler arm in front of the fire wall and the H.P.C. rod located before the engine control box and the length of the rod connecting the lever located before the engine control box and the engine control box pickup lever so that the engine control box pickup lever comes in positive contact with the L.O. stopper and, then, tighten the check nuts.

(G) Remove all the rig pins and place the H.P.C. lever of the pedestal in the feather position. Then, the engine control box pickup lever must be in positive contact with the F stopper. When the H.P.C. lever is placed in the high stop withdrawal position, the pickup lever must be in contact with the L.O. stopper positively.
After making sure that this requirement is met by moving the H.P.C. lever several times, paint the slip mark on the check nuts of the control rods in the nacelle.

D. Adjustment of High Pressure Guide Adjusting Plate Position

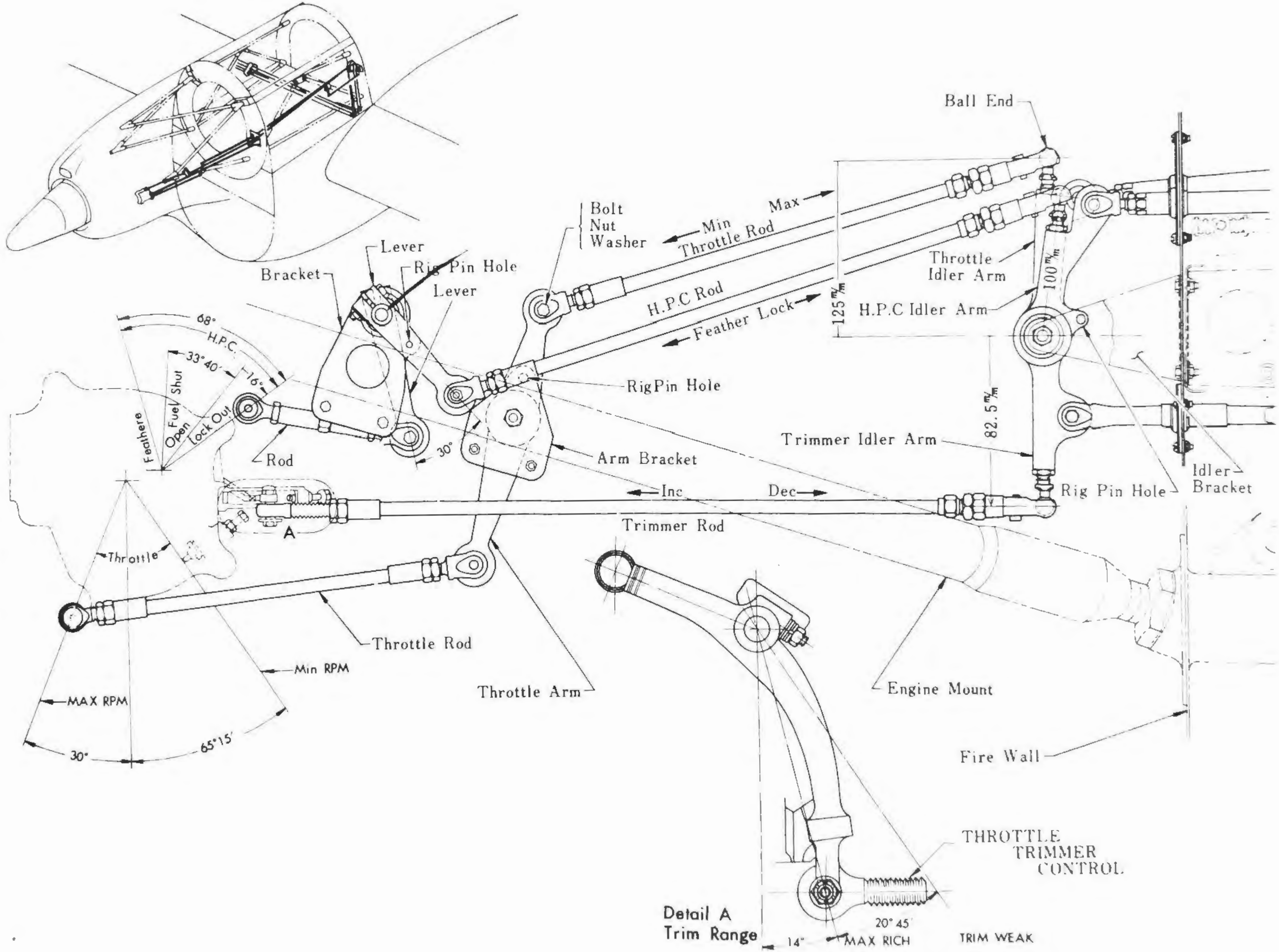
(A) Fix the ON position of the adjusting plate on the pedestal so that the pickup lever of the engine control box is lined up with "O" mark of the engine control box when the H.P.C. lever is pushed to the "ON" position and when it is pulled to the "ON" position.

NOTE: If the "O" mark of the engine control box is not clear, make sure that the lever mark of the engine F.C.U. is within the "Open" range and that the feathering selector lever mark of the engine P.C.U. is within the "RUN AUTO" range, instead of checking the alignment of "O" mark of the pickup lever.

(B) Adjust and fix the "OFF" position of the adjusting plate on the pedestal so that the pickup lever of the engine control box is lined up with the "S" mark of the engine control box when the H.P.C. lever is pushed to the "OFF" position and when it is pulled to the "OFF" position.

NOTE: If the "S" mark of the engine control box is not clear, make sure that the lever mark of the engine F.C.U. is within the "Shut" range and that the feathering selector lever mark of the engine P.C.U. is within the "UF" range, instead of checking the alignment of "S" mark of the pickup lever.

E. Check the control force of the H.P.C. lever at the following points and make sure that the control force is less than 7.5 lb.:



Push Pull Rod System in Engine Bay
Figure 4-39

(A) Check points

a. Behind the high stop withdrawal groove
b. In front of the fuel ON groove
c. Behind the fuel ON groove
d. In front of the fuel OFF groove
e. Behind the fuel OFF groove
f. In front of the feather groove.

(3) Adjustment of Throttle Trimmer

(A) Adjust the length of the arm, 01-64566-7 connecting the trim idler arm and the ball end to the standard dimension of 81.0 mm (reference) and adjust the length of the idler arm, 01-64592-41 on the fire wall to the standard dimension of 65.0 mm (reference).

(B) Set the trimmer switch of the pedestal in "INC" and make sure that the spring of the trim actuator rod end is not slack excessively.

(C) Set the gap between the trimmer pickup lever of the engine control box and the increase stopper to 0.012" to 0.014" and adjust the length of the rod connecting the fire wall idler arm ball end, engine pickup lever trimmer rod and lever from the trimmer actuator.

(D) Place the throttle pickup lever of the engine control box in contact with the min. stopper of the engine control box.

(E) Place the trimmer switch of the pedestal in DEC and extend the trimmer actuator fully. Then, make sure that the spring of the rod end of the trimmer actuator is not slack excessively.

(F) Make sure that the trimmer pickup lever of the engine control box is in contact with the decrease stopper positively.

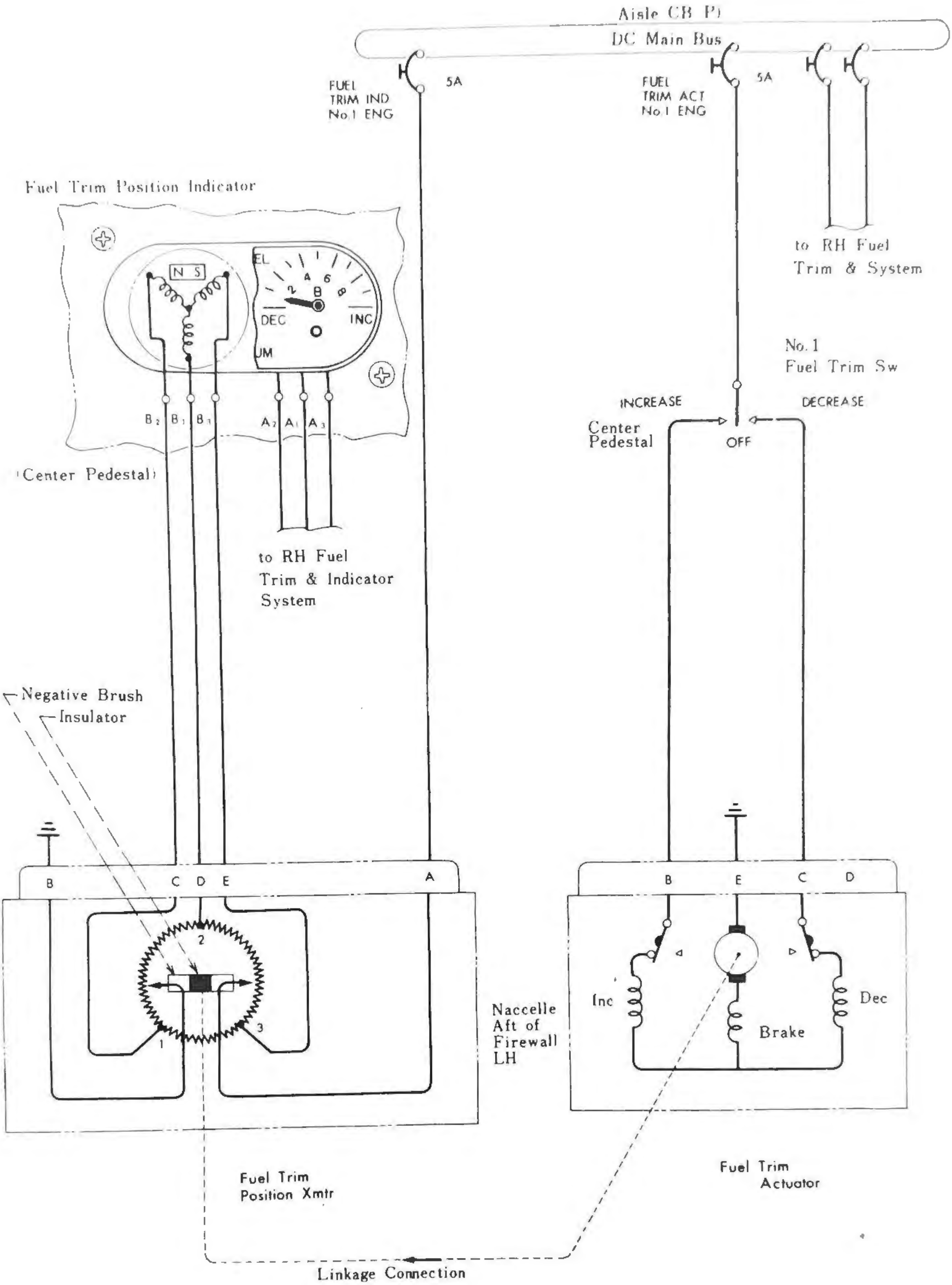
A. Adjustment of Trimmer Actuator -- Trimmer Position Transmitter -- Trimmer Position Indicator

(a) Adjust the length of the lever arm of the trimmer position transmitter to the design value of 50 mm (Fig. 4-30).

(b) Place the pedestal trimmer switch in INC while the throttle pickup lever of the engine control box is in contact with the max. stopper and extract the trimmer actuator fully. Adjust the length of the adjustable link so that the pedestal trimmer position indicator registers 100%.

(c) Place the pedestal trimmer switch in DEC while the throttle pickup lever is in contact with the min. stopper and extend the trimmer actuator fully. Make sure that the pedestal trimmer position indicator registers 0%.

NOTE: When the trimmer position indicator does not indicate 0%, repeat 8(3) A(b) and (c) to meet the requirements, neglecting 8(3) A(a) (adjusting the length of the arm of the trimmer position transmitter lever to values other than the design value).



Fuel Trim & Indication System Schematic
Figure 4-40

4.8.9 Emergency Shut Down System (Fig. 4-41)

(1) The emergency shut down system shuts down fuel and hydraulic oil supply to the engines and makes electrical circuits preliminarily for discharging of fire extinguishing agent.

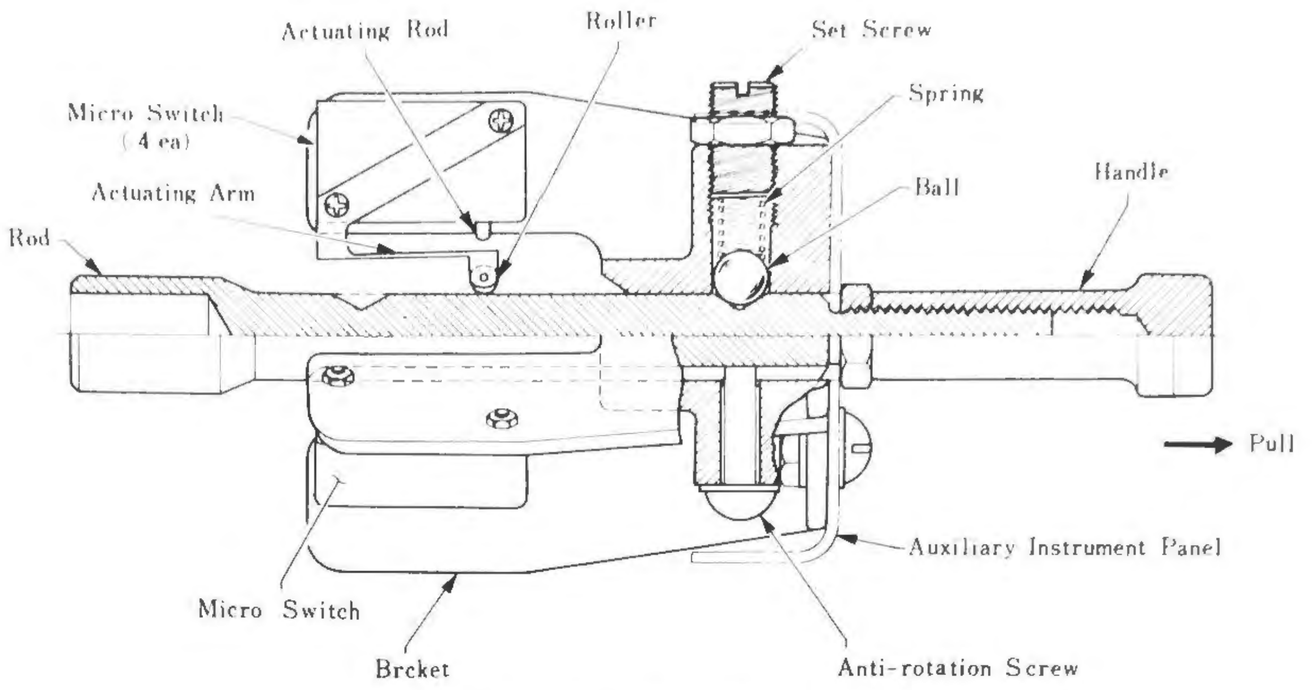
This system is not related to any other function.
The emergency shut off handles are provided 1 ea. for the engines on the auxiliary panel in the cockpit. If the handle is pulled, a micro switch is energized to make the circuit.

Once the circuit is made, the following units come into action:

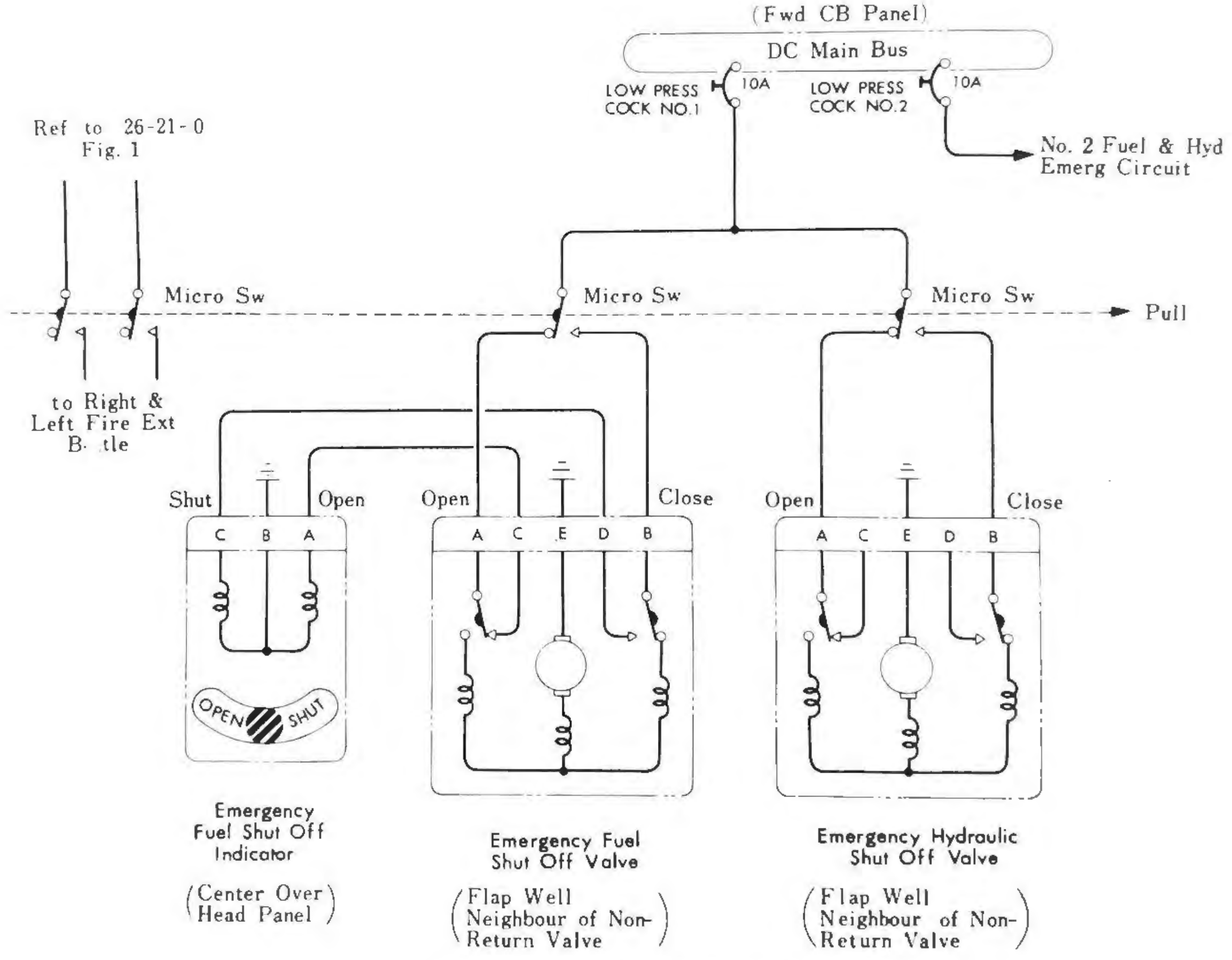
Emergency Fuel Shut Off Valve
Emergency Hydraulic Oil Shut Off Valve.

If the handle is pulled, the emergency fuel shut off indicator indicates "SHUT."

As a result, the fire extinguishing circuit is ready to discharge the fire extinguishing agent.



Emergency Shut off Handle



Emergency Shut off & Indicating Schem

Figure 4-41

4.9 Adjustment and Testing of Power Plant

4.9.1 General

4.9.1.1 Engine Serviceability Check

(1) After a new engine is installed or an engine is replaced.

(2) After a new propeller is installed or a propeller is replaced.

(3) After F.C.U., P.C.U., W/M unit or other units are replaced or after the engine control system is adjusted.

4.9.1.2 Other Aircraft Serviceability Check

4.9.1.3 In Case of Trouble Shooting

(1) When the flight performance is not satisfactory.

(2) When the engine starting is abnormal.

(3) When the engine speed is abnormal.

(4) When the torque pressure is abnormal.

(5) When rough running is suspected.

(6) When the oil system is malfunctioning.

(7) When the propeller system is malfunctioning.

(8) Others.

4.9.2 Ground Run-up Procedures

4.9.2.1 Environment of Run-up Site

(1) Be sure that the ground around the aircraft, especially the propellers is clean, and

(2) that the aircraft is located far enough from the other aircraft.

4.9.2.2 Preparation prior to Starting

(1) The aircraft against the wind within ± 30°.

(2) Assignment of required personnel

(3) Preparation of ground fire extinguishing equipment

(4) Desirable ground power unit

a. Maximum peak capacity: 2000A, 5 sec.
b. 1400A, 1 min.

c. Continuous rating in excess of 800A.

4.9.2.3 Precautions prior to Starting

(1) If the throttle lever and the H.P. cock lever are opened simultaneously while the engine is shut down and the power is on, the propeller auto feathering circuit is made and auto feathering takes place. It is desirable to trip the auto feathering circuit breaker to avoid this.

(2) Be sure that the propeller blade is at the ground fine pitch. (Make sure that the red marks on the spinner and the blade are lined up.)

(3) Make sure that sufficient amounts of fuel and W/M for ground running are loaded on the aircraft.

WARNING: 1. Avoid continuous operation at a speed less than 7,000 rpm.

2. Minimize engine operation at a speed between 12,000 and 14,000 rpm.

4.9.2.4 Precautions during Starting

(1) T.G.T. at engine starting shall not exceed 930°C. If the T.G.T. is about to exceed 930°C, place the H.P. cock lever in Fuel OFF and shut down the engine immediately.

(2) Never push the starter motor button while the propeller is still rotating.

(3) Do not pull out the starter button before the engine speed reaches 3500 rpm, or the engine is perfectly ignited except when the T.G.T. is excessively high.

(4) If the engine is not ignited within 20 sec. or the engine speed does not increase from the motoring speed, place the starter master switch in SAFE within 30 sec.

(5) Do not run the starter motor in excess of 30 sec.

4.9.2.5 Warning after Starting

(1) Make sure that the instruments in the cockpit are normal.

(2) Minimize the ground running time.

(3) Avoid the extended engine operation under maximum conditions.

(4) Avoid abrupt operation of the throttle lever and move it smoothly and slowly.

NOTE: If the throttle lever is moved abruptly, the torque pressure response will be delayed, resulting in auto feathering.

(5) When the engine speed is reduced from 15,000 rpm to 14,500 rpm, move the throttle lever slowly taking more than 5 sec.

NOTE: If the throttle lever is abruptly retarded, T.G.T. may overshoot. In order to avoid overheating which is likely to take place since the propeller may not be at the ground fine pitch, close the H.P. cock lever immediately.

(6) If the T.G.T. exceeds the specified limits during the engine run, close the H.P. cock lever (Fuel OFF) immediately.

(7) Do not open-up the throttle lever while the engine oil temperature is below -15°C.

(8) Set the fuel trimmer to the outside air temperature.

a. Move the trimmer gradually (especially when it is moved from DECREASE to INCREASE.)

b. Pay attention to the variation of the T.G.T. whenever the fuel trimmer is operated.

(9) Keep the H.P. cock lever in the high stop withdrawal position (H.S.W.D.) during all the ground running.

(10) Keep the gust lock lever in the lock position (the low stop lever in GROUND position) unless specified otherwise.

NOTE: Be on the alert especially when the low stop lever is moved to the flight position while the gust lock lever is in the unlock position.
In such a case, pitch coarsening will take place, varying the engine speed and the T.G.T. is likely to overshoot. Therefore, this abnormal condition calls for special attention.

4.9.3 Operating Limitation for Power Plant

4.9.3.1 Maximum Ambient Temperature ISA + 30°C

4.9.3.2 The engine operating limitation is as follows:

Condition	Engine speed rpm	Max. T.G.T. °C	Allowable max. duration
Starting	-	930	Momentary
Ground Idling	* 8000 ~ 8500	600	Unlimited
Approach Minimum	11,000	-	Unlimited
Other Conditions	less than 12,500 12,500 ~ 13,000 13,000 ~ 14,200 14,200 ~ 15,000	735 770 800 820	Unlimited
Maximum Continuous	15,000	890	Unlimited
Take-off With water methanol injection Without water methanol injection	 15,000 15,000	 890 865	5 min.
Overspeed	16,500	-	20 sec.

* The ground idling condition with the fuel trimmer at the maximum position at Static Sea Level, standard atmospheric conditions is determined by the fuel flow of 43.5 ± 1 Imp. Gal/hour (340 ± 6.5 lb/hr).

4.9.3.3 Oil Temperature and Oil Pressure

(1) Oil Inlet Temperature

a. Maximum 120°C
b. Minimum at starting -30°
c. Minimum for throttle opening up -15°C

(2) Oil Pressure

Minimum pressure at 12,000 rpm
13.5 psi at 55°C, and 12 psi at 115°C. The pressure between these two varies linearly in proportion to the temperature change. (more than 12 psi at 115°C to 120°C.)

4.9.3.4 In case of T.G.T. Overshoot

(1) If overheating takes place while the engine is running in the normal speed range, it is not necessary to remove the engine unless the T.G.T. exceeds the following limitation:

950°C for 5 sec. --- only for momentary rise.

If the T.G.T. reaches this limit, place the H.P. cock lever in Fuel OFF immediately.

(2) If the T.G.T. exceeds the normal operating maximum T.G.T. during the engine running, record it in the engine log book.

4.9.4 Engine Data

The engine data are given in the "inspection and test certificate" of the engine log book for the particular serial number.
The engine data plate is also used.
The data are based on the international standard atmosphere, sea level (I.S.A., S.L. conditions).

4.9.5 Data Plate Correction

Before commencing the ground run, it is necessary to correct the individual engine data according to the atmospheric conditions.

4.9.5.1 How to obtain atmospheric conditions

(1) Outside air temperature (O.A.T.)

It taken from the aircraft involved or a thermometer located in a nearby well ventilated run shade, free from the radiation effects.

(Reference)

It is desirable to use a thermometer located around the ADF sense antenna on the lower surface of the fuselage or around the lower part of the nose landing gear bay.

NOTE: O.A.T. value below the desimal point should be rounded to an integer by counting fractions of .5 and over as a whole number and disregarding the rest.

(2) Pressure Altitude

a. It is taken from the information given by the tower of the airport in which the ground run is conducted.

b. It is taken from the calibrated altimeter installed in the aircraft in terms of pressure in mercury column after setting it to the field elevation of the aircraft.

NOTE: 1. Either one of the above methods a. and b. may be used.

2. For the conversion between the pressure in mercury column and the pressure altitude, see Fig. 4-42.

4.9.5.2 T.G.T. Correction by Atmospheric Conditions

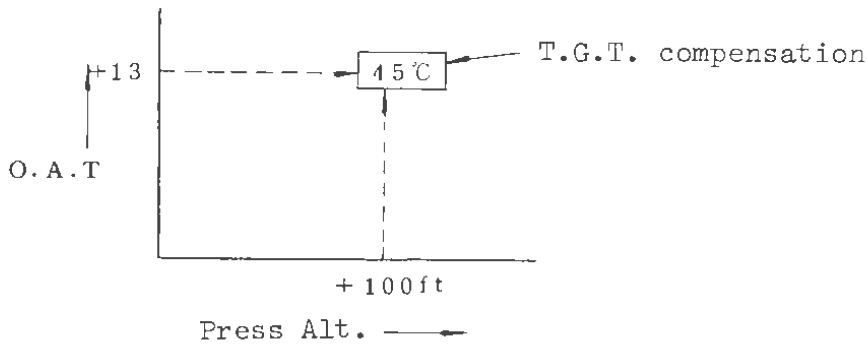
(1) Check the engine data.

(2) Based on O.A.T. and the pressure altitude at the location and the time, amount of compensation, using Figs. 4-43 and 4-44.

(Example)

Engine data	Max. T.G.T.	845°C	
	Min. T.G.T.	815°C	
Outside air temperature (O.A.T.)	+13°C		
Pressure altitude	29.83 Hg.in = + 85 ft ≒ 100 ft		

From T.G.T. corrections at 15,000 rpm (Graphical) Fig. 4-43
T.G.T. corrections at 15,000 rpm (Tabular) Fig. 4-44



(3) The amount of correction is obtained by subtracting the max. T.G.T. compensation calculated from the above table from the T.G.T. in the log book.

That is to say,

(Max. T.G.T. Data) - (Compensation) = Correction
(Min. T.G.T. Data) - (Compensation) = Correction

(Example)

Max. T.G.T. Correction = 845°C - 4.5°C = 840.5°C ≒ 841°C
Min. T.G.T. Correction = 815°C - 4.5°C = 810.5°C ≒ 811°C

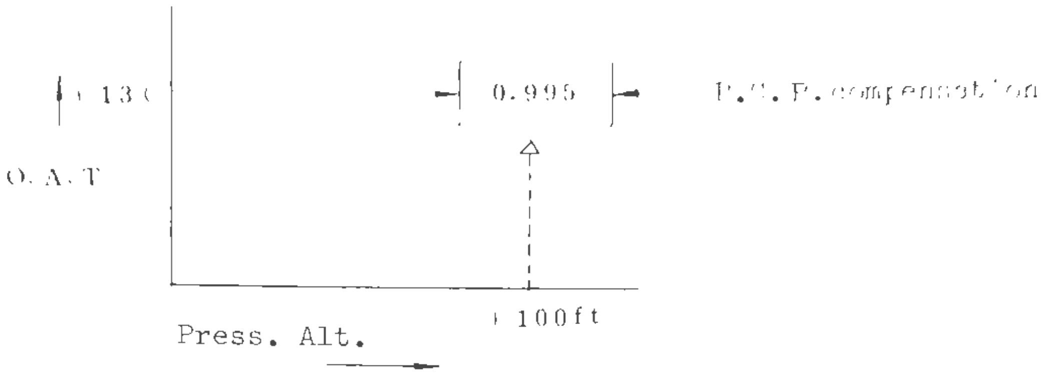
4.9.5.3 Engine Power Check Pressure (E.P.C.P.) Correction by Atmospheric Conditions

(1) Check the engine log book or the data plate.

(2) Based on O.A.T. and the pressure altitude at the location and the time, obtain the amount of compensation from the "correction to power check pressure" Fig. 4-45.

(Example)

Engine data	P.C.P.	345 psi
Outside air temperature (O.A.T.)		+13°C
Pressure altitude	29.83 Hg.in. = + 85 ft ≒ 100 ft	



(3) The amount of correction is obtained by multiplying the P.C.P. of the engine data by the P.C.P. compensation obtained from Fig. 4-45.

(Example)

Engine Data E.P.C.P. 345 psi
Outside air temperature (O.A.T.) +13°C
Pressure altitude 29.83 Hg.in.= + 85ft ≒ 100ft
P.C.P. compensation 0.995
Corrected E.P.C.P. = (Engine data plate P.C.P.) x (P.C.P. compensation) = 345psi x 0.995 = 342.27 psi
≒ 342 psi

NOTE: The correction value below the decimal point is rounded to an integer, by counting fractions of .5 a whole number and disregarding the rest.

4.9.5.4 Water Methanol Check Pressure Correction by Atmospheric Conditions

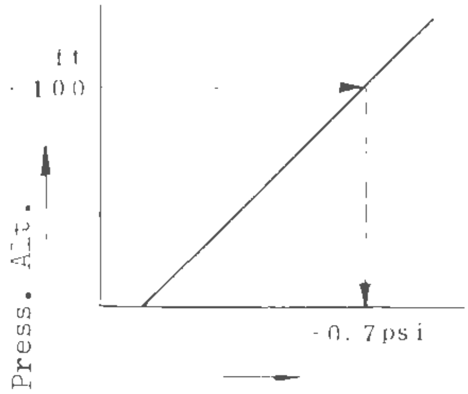
(1) Check the water methanol check pressure (W.M.C.P.) of the engine data plate.

(2) Based on the pressure altitude at the location, find the W.M.C.P. from the W.M.C.P, Fig. 4-48.

(Example)

Engine data: W.M.C.P. 410 psi
Pressure altitude: 29.83Hg.in. = + 85ft ≒ 100ft

From "Correction to W.M.C.P. for altitude" Fig. 4-48,



Corrections to be applied to data plate W.M.C.P-psi

(3) Add the W.M.C.P. compensation obtained in the above (2) to the W.M.C.P. of the engine data plate.

(Example)

Engine data: W.M.C.P. 410 psi
Pressure altitude: + 100ft
W.M.C.P. compensation:-0.7psi

W.M.C.P. correction = (Engine data plate W.M.C.P.) + (W.M.C.P. compensation)
= (410) + (-0.7 psi) = 409.3 psi ≒ 409 psi

4.9.5.5 Determination of Fuel Datum Position

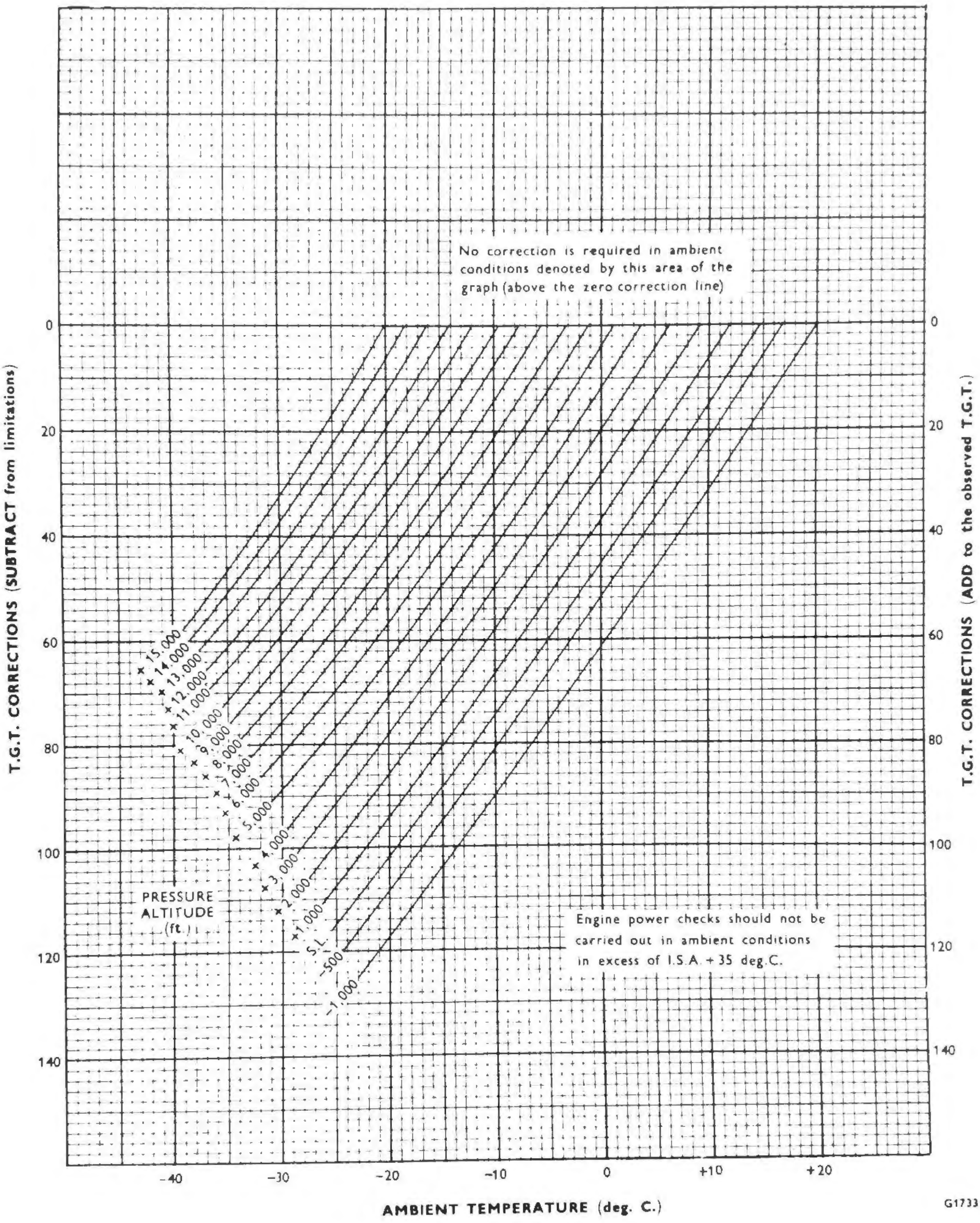
Table in Figs. 4-46 and 4-47 are used to determine the fuel datum position, based on the outside air temperature and the pressure altitude.

INCHES※	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
29.0	863	853	844	834	825	815	806	796	787	777
29.1	768	758	749	739	730	721	711	702	692	683
29.2	673	664	655	645	636	626	617	607	598	589
29.3	579	570	560	551	542	532	523	514	504	495
29.4	485	476	467	457	448	439	429	420	410	401
29.5	392	382	373	364	354	345	336	326	318	308
29.6	298	289	280	270	261	252	242	233	224	215
29.7	205	196	187	177	168	159	149	140	131	122
29.8	112	103	94	85	75	66	57	47	38	29
29.9	20	10	+1	-8	-17	-26	-36	-45	-54	-63
30.0	-73	-82	-91	-100	-110	-119	-128	-137	-146	-156
30.1	-165	-174	-183	-192	-202	-211	-220	-229	-238	-248
30.2	-257	-266	-275	-284	-293	-303	-312	-321	-330	-339
30.3	-348	-358	-367	-376	-385	-394	-403	-412	-421	-431
30.4	-440	-449	-458	-467	-476	-485	-495	-504	-513	-522
30.5	-531	-540	-549	-558	-567	-576	-585	-594	-604	-613

※ OF MERCURY

(ALTITUDE PRESSURE TABLE
(CONVERSION TABLE))

Figure 4-42



T.G.T. corrections at 15,000 r.p.m. (graphical)
Figure 4-43

Engine power checks should not be carried out in ambient conditions in excess of I.S.A. +35 deg. C.

NO CORRECTION

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+21	0																		+21
+19	3																		+19
+17	9	0																	+17
+15	16	6	0																+15
+13	22	12	5	0															+13
+11	28	18	12	3															+11
+ 9	34	24	18	10	0														+ 9
+ 7	40	30	24	16	7	0													+ 7
+ 5	46	36	30	22	13	4	0												+ 5
+ 3	52	43	36	28	20	10	2												+ 3
+ 1	58	49	42	34	26	17	8	0											+ 1
- 1	64	55	48	40	32	23	14	7	0										- 1
- 3	70	60	54	46	38	29	21	13	6	0									- 3
- 5	76	66	60	52	44	35	27	20	12	5	0								- 5
- 7	81	72	66	58	49	41	33	26	19	11	5	0							- 7
- 9	87	78	72	64	55	47	39	32	25	18	11	4	0						- 9
-11	92	83	79	69	61	53	45	38	31	24	17	10	4	0					-11
-13	98	89	83	74	66	58	51	44	37	30	23	16	10	3	0				-13
-15	104	94	88	80	72	64	56	50	43	36	29	23	16	9	3	0			-15
-17	109	100	94	86	78	70	62	55	48	41	35	29	23	16	10	3	0		-17
-19	114	105	99	91	83	75	68	61	54	47	41	34	29	22	16	9	3	0	-19
-21	120	111	104	96	88	81	73	66	59	52	46	40	34	28	22	16	9	3	-21
-23	126	116	110	102	94	86	79	72	64	58	52	46	40	34	28	22	16	10	-23
-25			115	107	99	92	84	77	70	63	57	51	46	40	34	28	22	16	-25
-27					104	97	90	82	75	68	62	56	51	45	40	34	28	23	-27
-29							95	87	80	73	68	62	56	50	46	40	34	29	-29
-31								91	84	78	72	66	61	56	51	46	40	35	-31
-33										83	77	72	66	61	56	51	46	41	-33
-35												76	71	66	61	56	51	47	-35
-37															66	61	56	52	-37
-39																		57	-39

PRESSURE ALTITUDE (ft.)

G1746

NOTE: Subtract the correction value obtained from this table from the appropriate T.G.T. limitation

T.G.T. corrections at 15,000 r.p.m. (tabular)

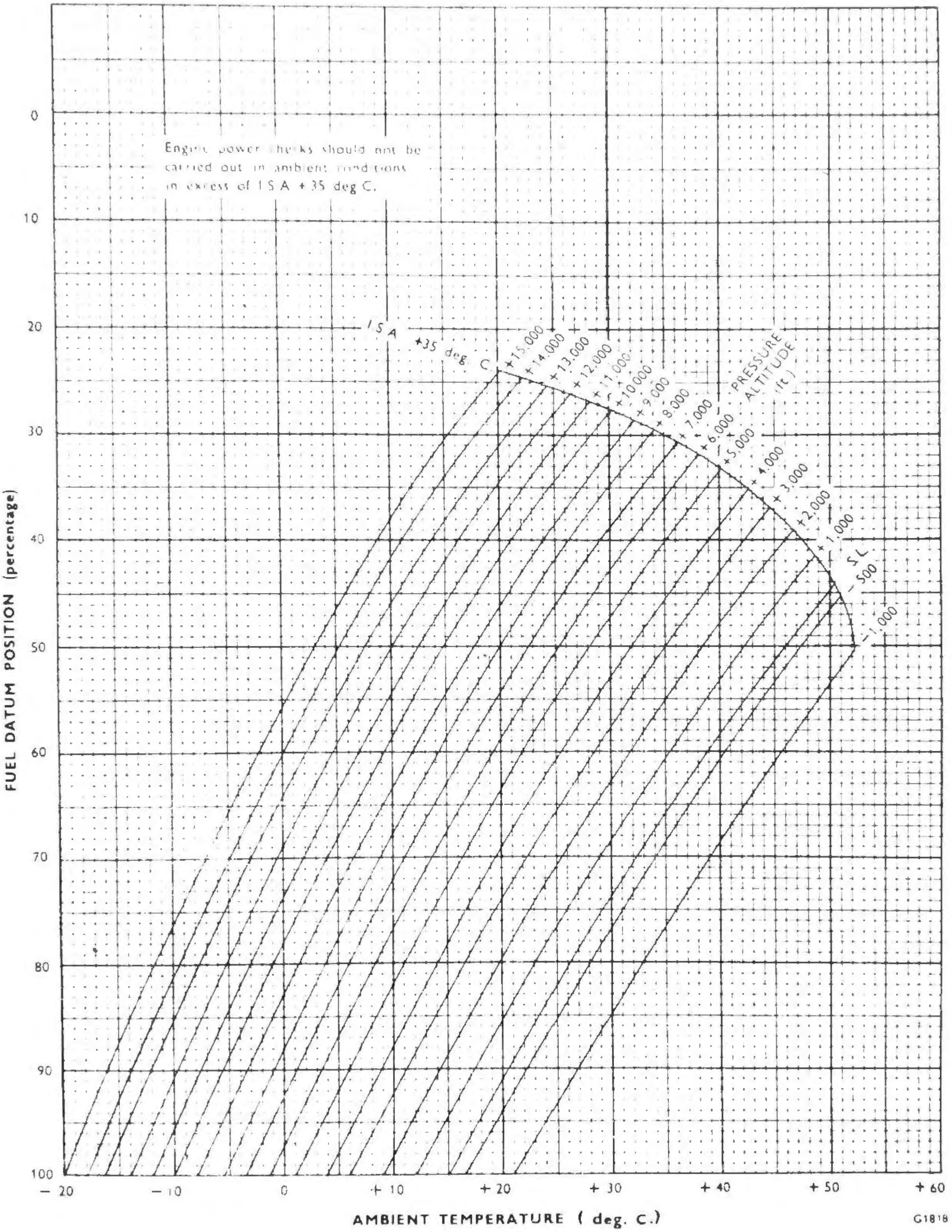
Figure 4-44

PREVAILING AIR TEMPERATURE - °C.	-1000	-500	-250	0	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
+45	.765	.752	.746	740	.726	.713	.685	.655	.629	.608					
+40	.805	.792	.783	.776	.764	.751	.720	.692	.666	.642	.611				
+35	.845	.831	.824	.816	.802	.790	.758	.731	.704	.679	.648	.625			
+30	.887	.873	.865	.858	.842	.829	.796	.770	.741	.715	.684	.660	.632		
+25	.933	.916	.908	.902	.885	.871	.837	.810	.782	.752	.720	.695	.666	.642	.615
+20	.981	.965	.955	.948	.931	.913	.880	.850	.823	.791	.760	.731	.702	.676	.648
+15	1.015	1.008	1.004	1.00	.981	.960	.925	.893	.863	.830	.798	.768	.737	.710	.682
+10	1.008	1.001	1.00	.995	.988	.980	.965	.938	.905	.870	.837	.806	.775	.745	.716
+5	1.002	.995	.992	.988	.981	.975	.960	.945	.930	.912	.880	.845	.814	.784	.751
0	.993	.988	.985	.980	.975	.968	.955	.941	.926	.910	.895	.880	.855	.823	.790
-5	.985	.979	.975	.971	.966	.960	.946	.933	.920	.905	.892	.877	.862	.846	.830
-10	.975	.970	.966	.963	.958	.952	.938	.925	.912	.898	.885	.871	.856	.840	.825
-15	.965	.959	.955	.952	.946	.942	.929	.915	.894	.888	.875	.863	.849	.832	.819
-20	.955	.948	.945	.941	.937	.930	.918	.905	.892	.879	.863	.850	.838	.820	.808
-25	.942	.937	.934	.930	.924	.920	.905	.892	.880	.867	.852	.835	.822	.805	.792
-30	.929	.923	.920	.916	.912	.905	.894	.878	.866	.855	.837	.819	.805	.788	.775
-35	.916	.912	.906	.904	.895	.891	.879	.862	.850	.839	.821	.800	.785	.770	.754
-40	.905	.898	.894	.888	.883	.877	.866	.846	.835	.825	.806	.784	.768	.751	.729

Multiply engine power check pressure by factor

PRESSURE ALTITUDE - ft.

Figure 4-45 Corrections to power check pressure



Fuel datum position (graphical)
Figure 4-46

Engine power checks should not be carried out in ambient conditions denoted by this area of the table

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+51	52																		+51
+49	55	48	46																+49
+47	58	51	49	44															+47
+45	61	53	51	46	41														+45
+43	64	56	54	49	44	39													+43
+41	67	59	57	52	46	42	37												+41
+39	70	62	60	55	49	45	40	35											+39
+37	73	65	63	58	52	47	43	38	33										+37
+35	76	69	66	61	55	50	45	40	36	32									+35
+33	80	72	69	64	58	53	48	43	39	35	31								+33
+31	83	75	72	67	61	56	51	46	41	38	34	30							+31
+29	86	79	75	70	65	59	55	49	44	40	36	33	29						+29
+27	90	82	79	73	68	62	58	52	47	43	39	36	32	29					+27
+25	93	85	82	77	71	66	61	55	51	46	42	39	34	31	28				+25
+23	97	89	85	80	74	69	64	59	54	49	45	42	37	34	30	27			+23
+21	100	92	89	83	78	72	68	62	57	53	48	45	40	37	33	30	26		+21
+19		96	93	87	81	76	71	65	61	56	52	48	43	40	36	32	29	25	+19
+17		99	96	91	85	79	75	69	64	60	55	51	46	43	39	35	31	28	+17
+15		100	100	94	89	83	78	72	68	63	59	54	50	46	42	38	34	31	+15
+13				98	92	87	82	76	71	67	62	58	53	49	45	41	37	34	+13
+11				100	96	90	86	80	75	70	66	62	57	53	48	44	40	37	+11
+ 9					100	94	90	84	79	74	70	65	60	56	52	48	44	40	+ 9
+ 7						98	94	88	83	78	73	69	64	60	56	51	47	43	+ 7
+ 5						100	98	92	87	82	77	73	68	64	59	55	50	46	+ 5
+ 3							100	96	91	86	82	77	72	68	63	59	54	50	+ 3
+ 1								100	95	90	86	81	76	72	67	62	58	54	+ 1
- 1									99	94	90	85	80	76	71	66	62	58	- 1
- 3									100	99	94	89	84	80	75	70	66	62	- 3
- 5										100	99	93	89	84	79	74	70	66	- 5
- 7											100	98	93	89	84	78	74	70	- 7
- 9												100	98	93	88	83	79	74	- 9
-11													100	98	93	87	83	79	-11
-13														100	97	92	88	83	-13
-15															100	97	93	88	-15
-17																100	97	93	-17
-19																	100	98	-19
-21																		100	-21

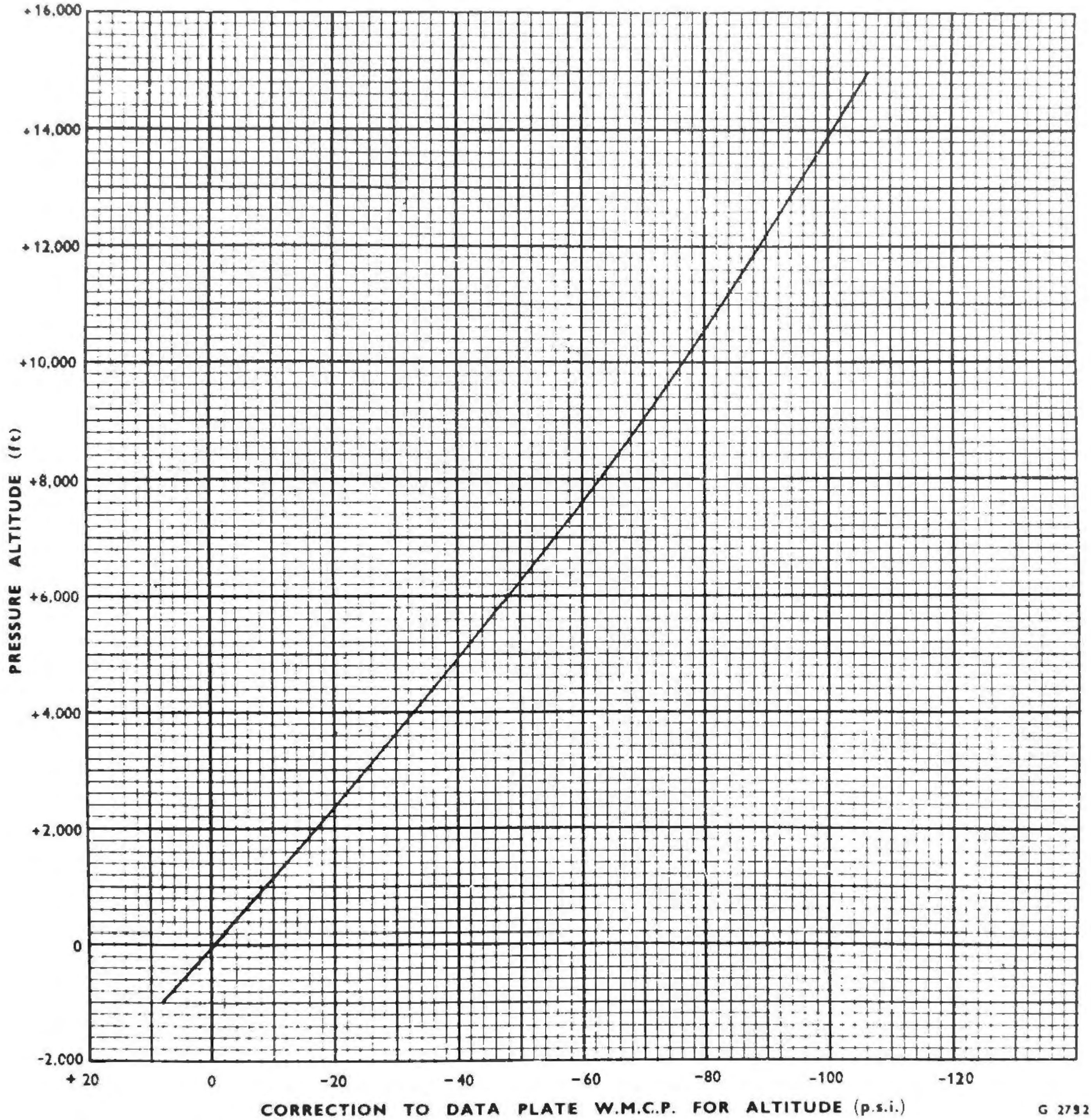
FULL INCREASE

PRESSURE ALTITUDE (ft.)

G1824

Fuel datum position (tabular)

Figure 4-47



Corrections to W.M.C.P. for altitude
Figure 4-48

4.9.5.6 Correction for Humidity

The fuel datum setting and power check pressures may be corrected for humidity if necessary.

NOTE: Unless it is known that conditions of very high humidity prevail, the humidity corrections need not be used for routine ground runs, and reference to these corrections should be ignored. The humidity corrections should be used on engines with low torque pressure which may, given the benefit of the correction, avoid being rejected.

(Example)

Engine data:

Ambient (dry bulb - T_o) temperature	+13°C
Wet bulb (T_W) temperature	+12°C
Pressure altitude	29.83hg.in≒100ft
MAX T.G.T	845°C
MIN T.G.T	815°C
E.P.C.P	345 psi
W.M.C.P	410 psi

(1) T.G.T Correction

Based on O.A.T and the pressure altitude at the location and the time, amount of compensation, using Fig. 4-43 and 4-44

(Example)

Max. T.G.T Correction = 845°C - 4.5°C = 840.5°C ≒ 841°C
Min. T.G.T Correction = 815°C - 4.5°C = 810.5°C ≒ 811°C

(2) W.M.C.P Correction

Based on the pressure altitude at the location, amount of compensation, using Fig. 4-48.

(Example)

W.M.C.P Correction = 410 psi + (-0.7 psi)
= 409.3 psi ≒ 409 psi

(3) E.P.C.P Correction

There are two methods of solution for correction so that graphical solution, and tabular solution. In practice it will usually be necessary to interpolate between the figures given in the tables.

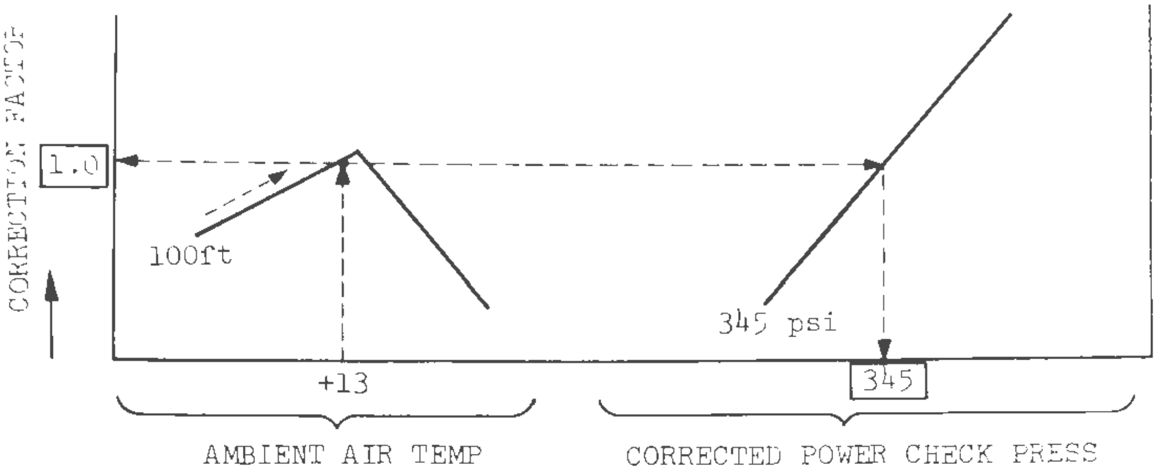
A. Graphical Solution

(A) Correct the power check pressure for the prevailing ambient

temperature and pressure altitude, using Fig. 4-49, Fig 4-50.

Fig. 4-49 .... Full range
Fig. 4-50 .... Reduced range

(Example)

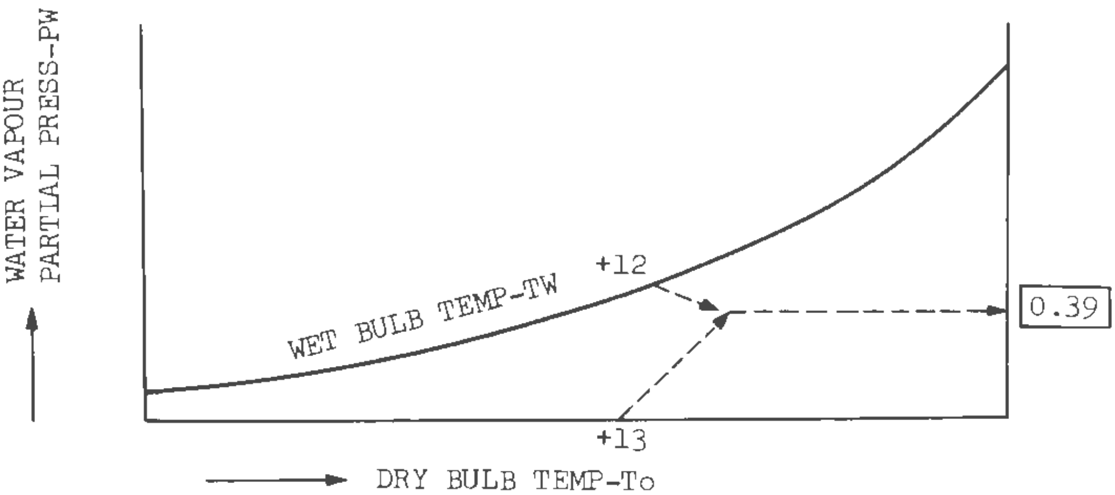


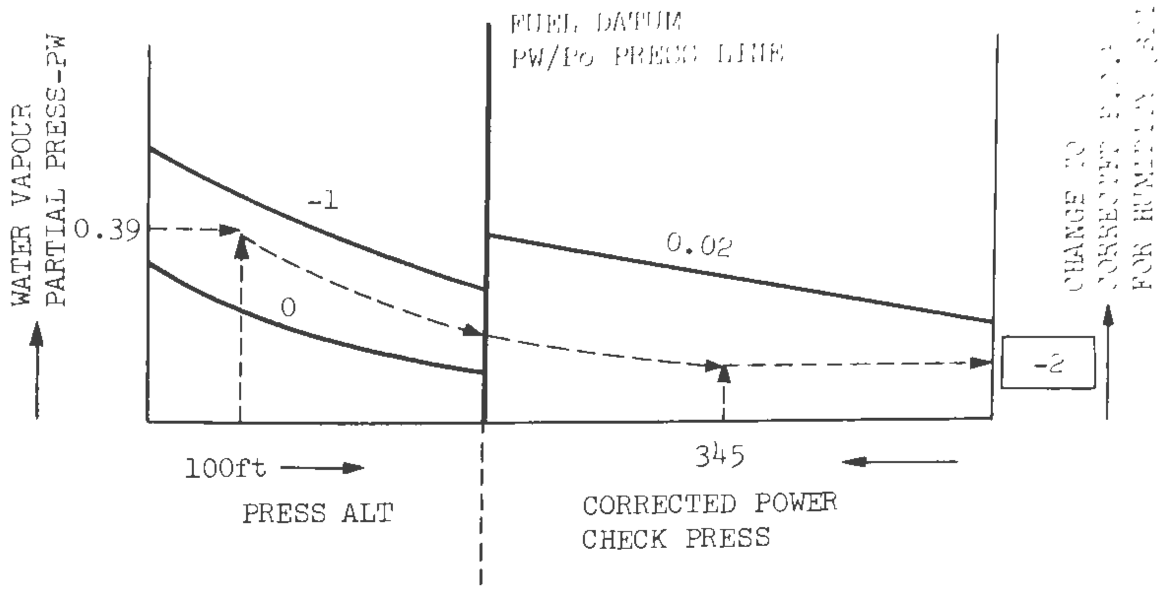
The amount of corrected power check pressure obtained from Fig. 4-49 is as following.

Corrected P.C.P = 345 psi

(B) Change the corrected P.C.P for humidity, using Fig. 4-53, Fig 4-54.

(Example)





The corrected E.P.C.P for humidity
= (Corrected P.C.P of engine data plate) + (P.C.P compensation for humidity)

= 345 psi + (-2 psi) = 243 psi

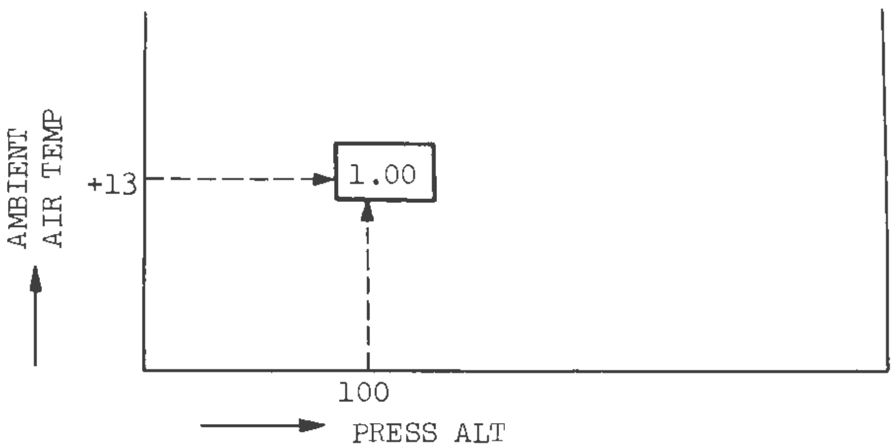
This is the corrected E.P.C.P value for humidity.

B. Tabular solution

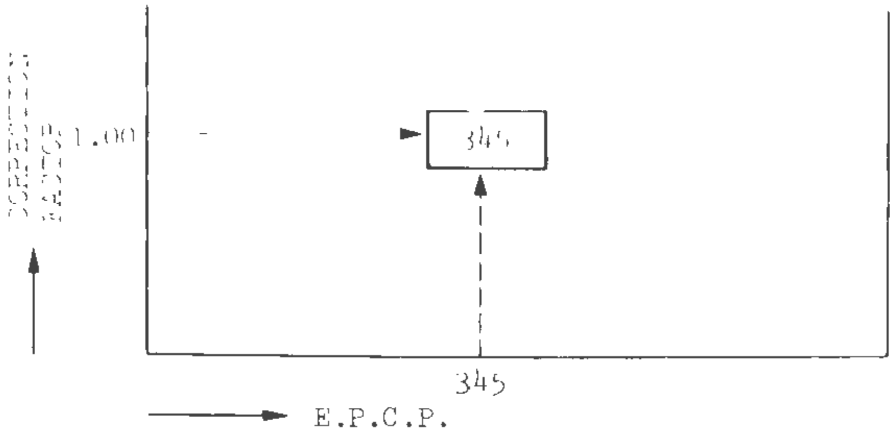
NOTE: In practice it will usually be necessary to interpolate between the figures given in the tables.

(A) Correct the power check pressure for the prevailing ambient temperature and pressure altitude, using Fig. 4-51, Fig. 4-52.

(Example)



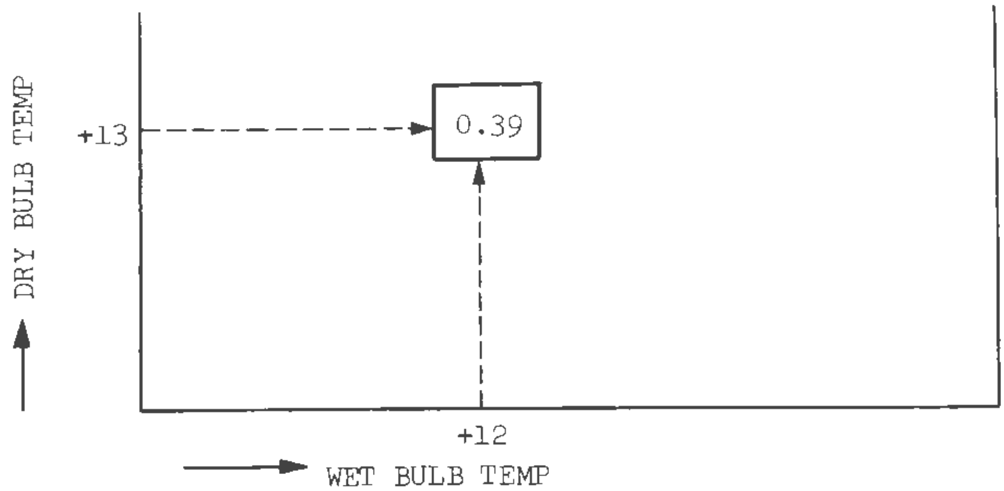
CORRECTION FACTOR = 1.00

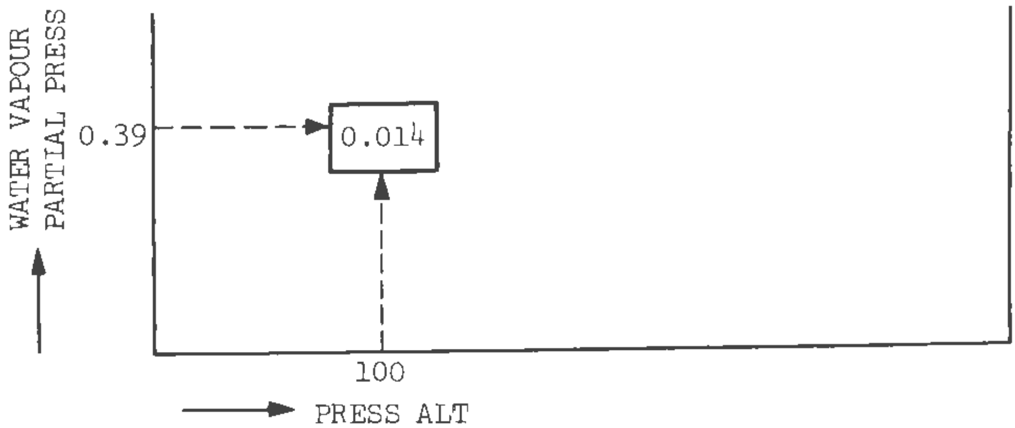


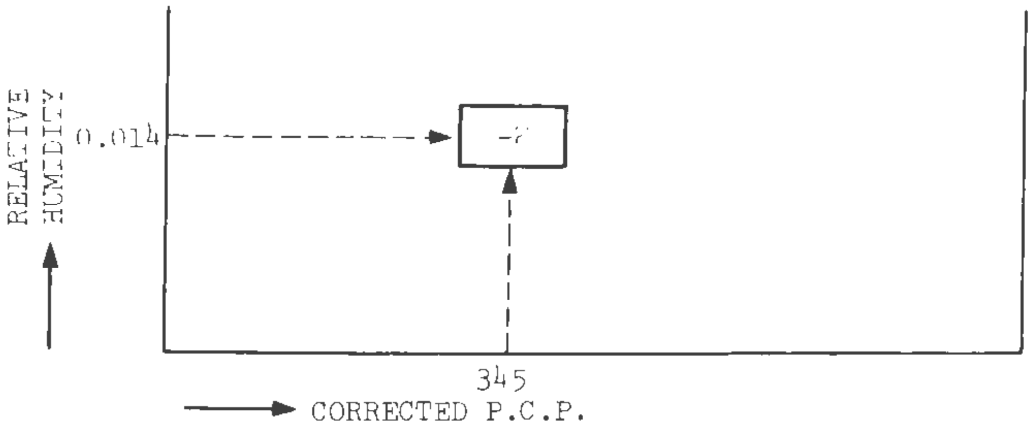
CORRECTED P.C.P=345PSI

(B) Change the corrected P.C.P for humidity, using Fig. 4-55, Fig. 4-57, Fig. 4-58.

(Example)







The corrected E.P.C.P for humidity
= (Corrected P.C.P of engine data plate) + (P.C.P compensation for humidity)

= 345 psi + (-2 psi) = 243 psi

This is the corrected E.P.C.P value for humidity.

(4) Fuel Datum Setting

A. Graphical Solution

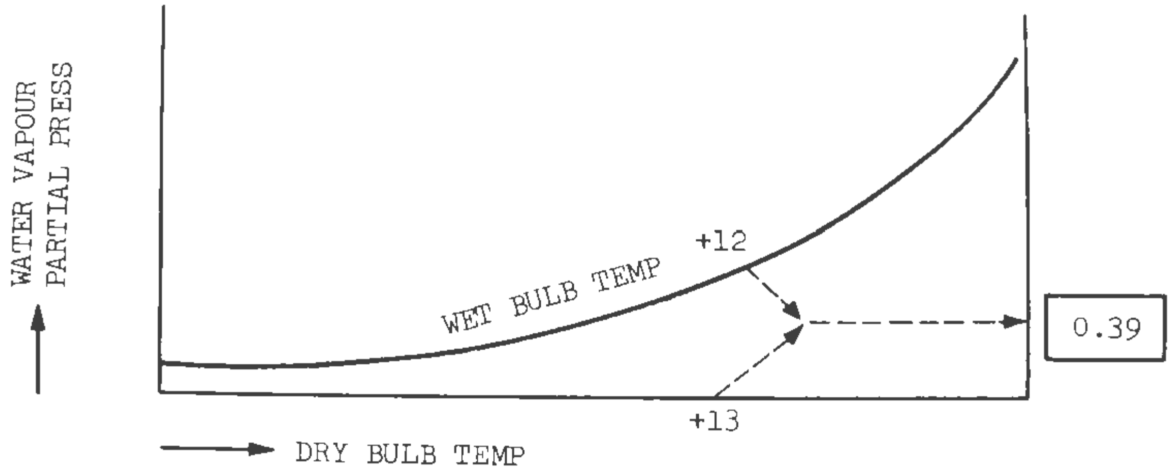
(A) Set the fuel datum for the prevailing ambient temperature, using Fig. 4-46, Fig. 4-47.

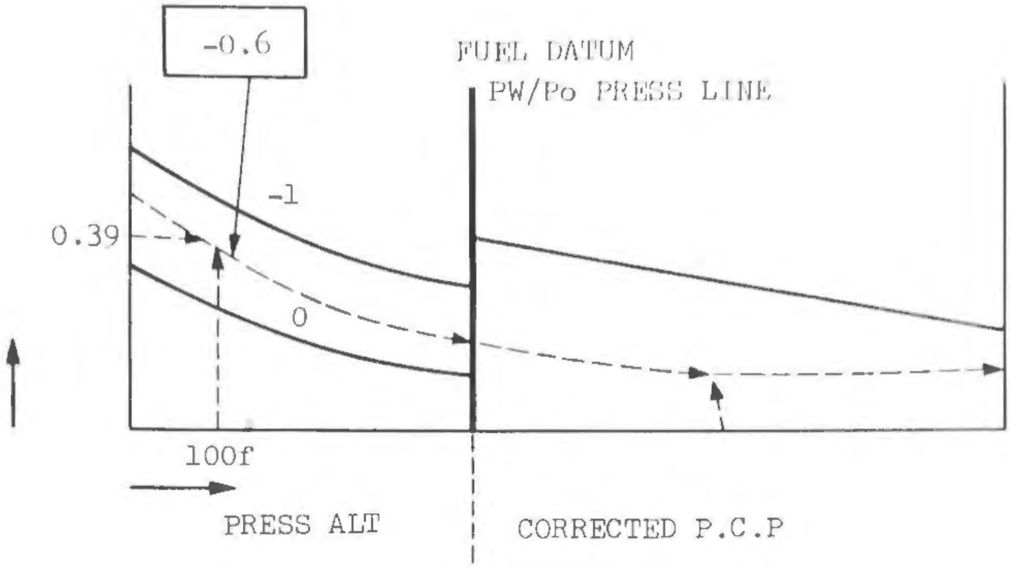
(Example) O.A.T +13°C

Fuel datum setting 100%

(B) Correct the fuel datum setting for the humidity, using Fig. 4-53, Fig. 4-54.

(Example)





The corrected fuel datum setting for humidity
= (Corrected fuel datum setting of prevailing ambient temp.)
+ (Setting compensation for humidity)
= 100 + (-0.6) ≒ 99%

This is the corrected fuel datum value for humidity.

B. Tabular Solution

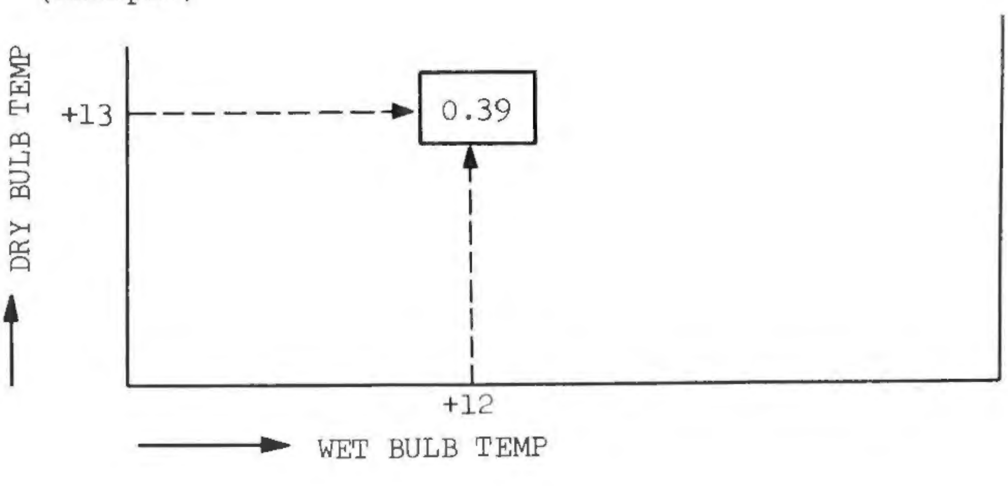
(A) Set the fuel datum for the prevailing ambient temperature using Fig. 4-46, Fig. 4-47.

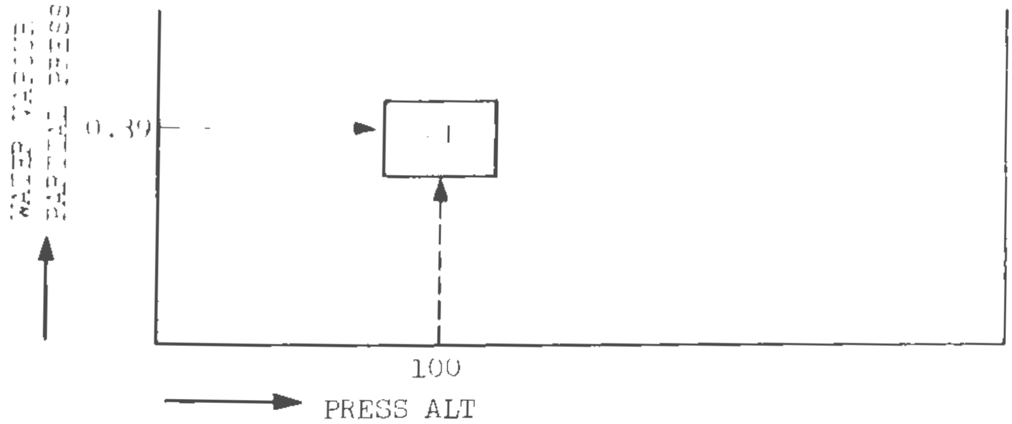
(Example)

O.A.T .... +13°C
Fuel datum setting 100%

(B) Correct the fuel datum setting for the humidity, using Fig. 4-55, Fig. 4-56.

(Example)





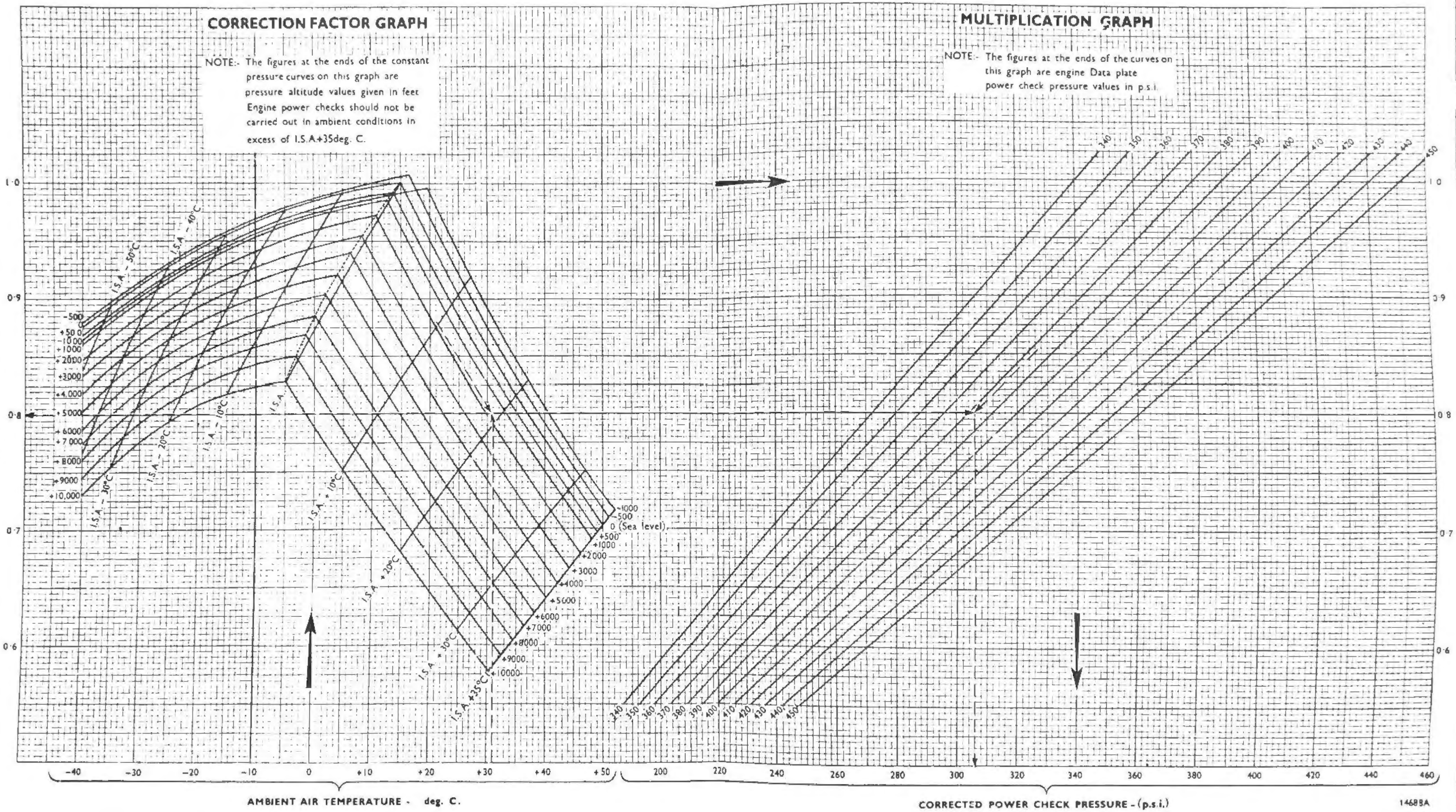
The corrected fuel datum setting for humidity.

= (Corrected fuel datum setting of prevailing ambient temp.
+ (Setting compensation for humidity)

= 100 + (-1) = 99%

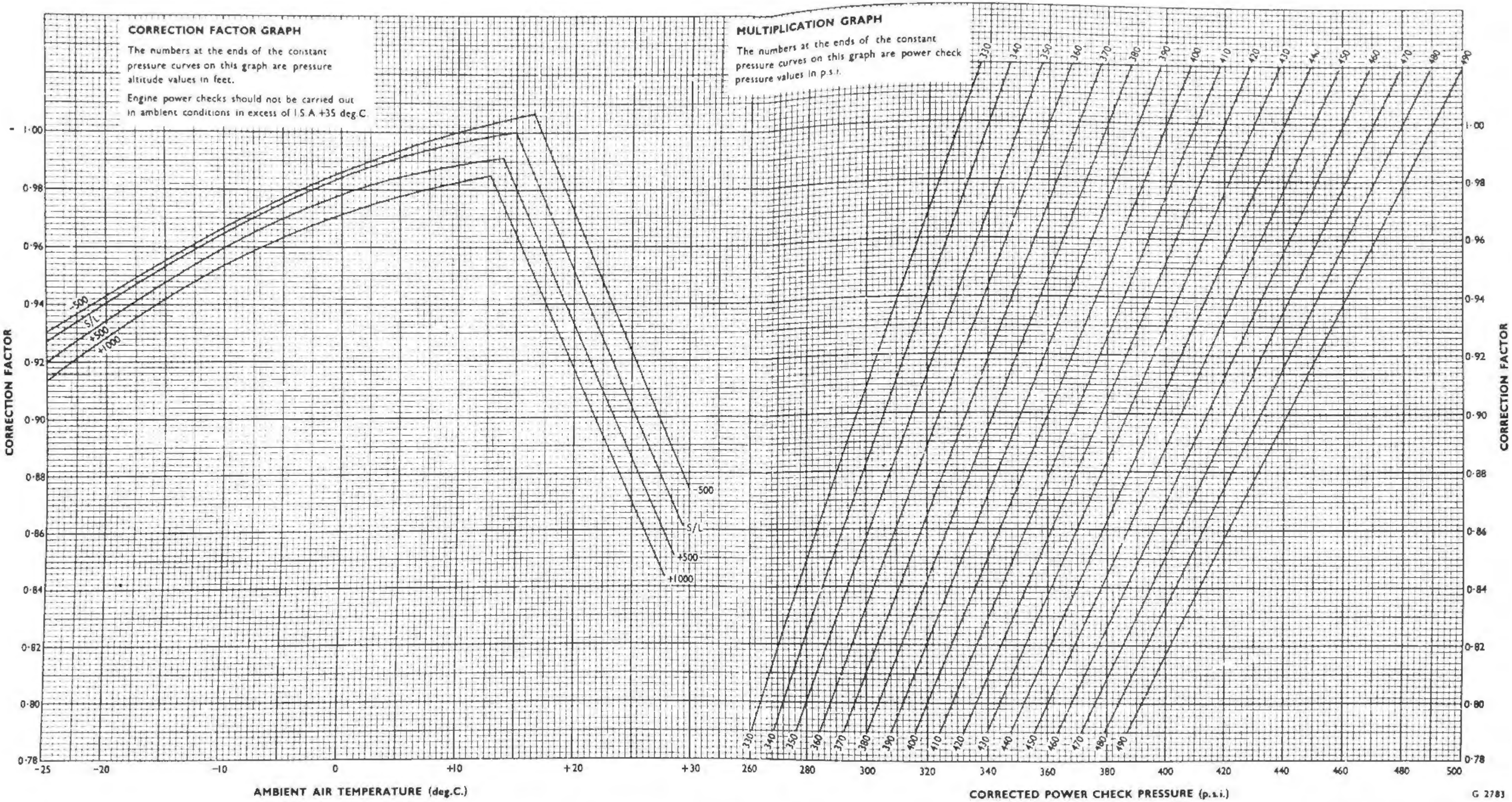
This is the correction fuel datum value for humidity.

Reserved



Corrections to Power Check Pressure
(full range) - graphical
Figure 4-49

NOTE: A tabular representation of this graph is shown in Fig.507a and 507b, and a reduced range graph with extended scale is shown in Fig. 4-50



NOTE: A tabular representation of this graph is shown in Fig. 4-51 and 4-52 and a full range graph with a reduced scale is given in Fig. 4-49.

Corrections to Power Check Pressure
(reduced range) - graphical
Figure 4-50

CORRECTION TABLE

Ambient air temperature (deg C.) \ Pressure altitude (ft.)	-1,000	-500	0	+500	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000
+50	0.73	0.72	0.70	0.69	0.68	0.65	Engine power check should not be carried out in ambient conditions in excess of I.S.A. + 35 deg C							
+45	0.77	0.75	0.74	0.73	0.71	0.69	0.66	0.63						
+40	0.81	0.79	0.78	0.76	0.75	0.72	0.69	0.67	0.64	0.62				
+35	0.85	0.83	0.82	0.80	0.79	0.76	0.73	0.70	0.68	0.65	0.63	0.60		
+30	0.89	0.87	0.86	0.84	0.83	0.80	0.77	0.74	0.71	0.69	0.66	0.63	0.61	0.58
+25	0.94	0.92	0.90	0.89	0.87	0.84	0.81	0.78	0.75	0.72	0.69	0.67	0.64	0.61
+20	0.99	0.97	0.95	0.93	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70	0.68	0.65
+15	0.99	1.01	1.00	0.98	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74	0.71	0.68
+10	0.99	1.00	1.00	0.99	0.98	0.97	0.94	0.91	0.87	0.84	0.81	0.78	0.75	0.72
+ 5	0.98	0.99	0.99	0.98	0.98	0.97	0.95	0.94	0.91	0.88	0.85	0.82	0.79	0.75
0	0.97	0.99	0.98	0.98	0.97	0.96	0.94	0.93	0.92	0.90	0.88	0.86	0.82	0.79
- 5	0.97	0.98	0.98	0.97	0.96	0.95	0.94	0.92	0.91	0.90	0.88	0.87	0.85	0.83
-10	0.96	0.97	0.97	0.96	0.95	0.94	0.93	0.92	0.90	0.89	0.87	0.86	0.84	0.82
-15	0.94	0.96	0.95	0.95	0.94	0.93	0.92	0.91	0.89	0.88	0.86	0.85	0.83	0.82
-20	0.93	0.94	0.94	0.94	0.93	0.92	0.91	0.89	0.88	0.87	0.85	0.84	0.82	0.81
-25	0.92	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.86	0.85	0.84	0.82	0.81	0.79
-30	0.90	0.91	0.91	0.90	0.90	0.89	0.87	0.86	0.85	0.83	0.82	0.81	0.79	0.78
-35	0.88	0.90	0.89	0.89	0.89	0.87	0.85	0.84	0.83	0.81	0.80	0.79	0.77	0.76
-40	0.86	0.88	0.88	0.87	0.86	0.85	0.83	0.82	0.80	0.79	0.78	0.76	0.75	0.73

PRESSURE ALTITUDE (ft.)

G2800

Corrections to Power Check Pressure - tabular
Figure 4-51

NOTE: A graphical representation of this table is shown in Fig.4-49(full range) and Fig.4-50(reduced range).

Reserved

1.03	309	314	319	324	330	335	340	345	350	355	361	366	371	376	381	386	391	397	402	407	412	417	422	427	433	438	443	448	453	458	464	469	474	479	484	489	494	500	505	510	515	520	525	530	536	541	546	551	556	561	567	572	577	580	587	592	597	603	608	613	618	1.03
1.02	306	311	316	321	326	332	337	342	347	352	357	362	367	372	377	383	388	393	398	403	408	413	418	423	428	434	439	444	449	454	459	464	469	474	479	485	490	495	500	505	510	515	520	525	530	536	541	546	551	556	561	566	571	576	581	587	592	597	602	607	612	1.02
1.01	303	308	313	318	323	328	333	338	343	348	354	359	364	369	374	379	384	389	394	399	404	409	414	419	424	429	434	439	444	449	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	556	561	566	571	576	581	586	591	596	601	606	1.01
1.00	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	576	580	585	590	595	600	1.00
0.99	297	302	307	312	317	322	327	332	337	342	347	351	356	361	366	371	376	381	386	391	396	401	406	411	416	421	426	431	436	441	446	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	549	554	559	564	569	574	579	584	589	594	0.99
0.98	294	299	304	309	314	319	323	328	333	338	343	348	353	358	363	368	372	377	382	387	392	397	402	407	412	417	421	426	431	436	441	446	451	456	461	466	470	475	480	485	490	495	500	505	510	515	519	524	529	534	539	544	549	554	559	564	568	573	578	583	588	0.98
0.97	291	296	301	306	310	315	320	325	330	335	341	344	349	354	359	364	369	373	378	383	388	393	398	403	407	412	417	422	427	432	437	441	446	451	456	461	466	470	475	480	485	490	495	500	504	509	514	519	524	529	534	538	543	548	553	558	563	567	572	577	582	0.97
0.96	288	293	298	302	307	312	317	322	326	331	336	341	346	350	355	360	365	370	374	379	384	389	394	398	403	408	413	418	422	427	432	437	442	446	451	456	461	466	470	475	480	485	490	494	499	504	509	514	518	523	528	533	538	542	547	552	557	562	566	571	576	0.96
0.95	285	290	295	299	304	309	314	318	323	328	333	337	342	347	352	356	361	366	371	375	380	385	390	394	399	404	409	413	418	423	428	432	437	442	447	451	456	461	466	470	475	480	485	489	494	499	504	508	513	518	523	527	532	537	542	546	551	556	561	565	570	0.95
0.94	282	287	291	296	301	306	310	315	320	324	329	334	338	343	348	353	357	362	367	371	376	381	385	390	395	400	404	409	414	418	423	428	432	437	442	447	451	456	461	465	470	475	479	484	489	494	498	503	508	512	517	522	526	531	536	541	545	550	555	559	564	0.94
0.93	279	284	288	293	298	302	307	312	316	321	326	330	335	339	344	349	353	358	363	367	372	377	381	386	391	395	400	405	409	414	419	423	428	432	437	442	446	451	456	460	465	470	474	479	484	488	493	498	502	507	512	516	521	525	530	535	539	544	549	553	558	0.93
0.92	276	281	285	290	294	299	304	308	313	317	322	327	331	336	340	345	350	354	359	363	368	373	377	382	386	391	396	400	405	409	414	419	423	428	432	437	442	446	451	455	460	465	469	474	478	483	488	492	497	501	506	511	515	520	524	529	534	538	543	547	552	0.92
0.91	273	278	282	287	291	296	300	305	309	314	319	323	328	332	337	341	346	350	355	359	364	369	373	378	382	387	391	396	400	405	410	414	419	423	428	432	437	441	446	450	455	460	464	469	473	478	482	487	491	496	501	505	510	514	519	523	528	532	537	541	546	0.91
0.90	270	275	279	284	288	293	297	302	306	312	315	320	324	329	333	338	342	347	351	356	360	365	369	374	378	383	387	392	396	401	405	410	414	419	423	428	432	437	441	446	450	455	459	464	468	473	477	482	486	491	495	500	504	509	513	518	522	527	531	536	540	0.90
0.89	267	271	276	280	285	289	294	298	303	307	312	316	320	325	329	334	338	343	347	352	356	360	365	369	374	378	383	387	392	396	401	405	409	414	418	423	427	432	436	441	445	449	454	458	463	467	472	476	481	485	490	494	498	503	507	512	516	521	525	530	534	0.89
0.88	264	268	273	277	282	286	290	295	299	304	308	312	317	321	326	330	334	339	343	348	352	356	361	365	370	374	378	383	387	392	396	400	405	409	414	418	422	427	431	436	440	444	449	453	458	462	466	471	475	480	484	488	493	497	502	506	510	515	519	524	528	0.88
0.87	261	265	270	274	278	283	287	291	296	300	305	309	313	318	322	326	331	335	339	344	348	352	357	361	365	370	374	378	383	387	392	396	400	405	409	413	418	422	426	431	435	439	444	448	452	457	461	465	470	474	479	483	487	492	496	500	505	509	513	516	522	0.87
0.86	258	262	267	271	275	280	284	288	292	297	301	305	310	314	318	323	327	331	335	340	344	348	353	357	361	366	370	374	378	383	387	391	396	400	404	409	413	417	421	426	430	434	439	443	447	452	456	460	464	469	473	477	482	486	490	495	499	503	507	512	516	0.86
0.85	255	259	264	268	272	276	281	285	280	293	298	302	306	310	315	319	323	327	332	336	340	344	349	353	357	361	366	370	374	378	383	387	391	395	400	404	408	412	417	421	425	429	434	438	442	446	451	455	459	463	468	472	476	480	485	489	493	497	502	505	510	0.85
0.84	252	256	260	265	269	273	277	281	286	290	294	298	302	307	311	315	319	323	328	332	336	340	344	349	353	357	361	365	370	374	378	382	386	391	395	399	403	407	412	416	420	424	428	433	437	441	445	449	454	458	462	466	470	475	479	483	487	491	496	500	504	0.84
0.83	249	253	257	261	266	270	274	278	282	286	291	295	299	303	307	311	315	320	324	328	332	336	340	344	349	353	357	361	365	369	374	378	382	386	390	394	398	403	407	411	415	419	423	427	432	436	440	444	448	452	457	461	465	469	473	477	481	486	490	494	498	0.83
0.82	246	250	254	258	262	267	271	275	279	282	287	291	295	299	303	308	312	316	320	324	328	332	336	340	344	349	353	357	361	365	369	373	377	381	385	390	394	398	402	406	410	414	418	422	426	431	435	439	443	447	451	455	459	463	467	472	476	480	484	488	492	0.82
0.81	243	247	251	255	259	263	257	271	275	279	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	360	365	369	373	377	381	385	389	393	397	401	405	409	413	417	421	425	429	433	437	441	446	450	454	458	462	466	470	474	478	482	486	0.81
0.80	240	244	248	252	256	260	264	268	272	276	280	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	360	364	368	372	376	380	384	388	392	396	400	404	408	412	416	420	424	428	432	436	440	444	448	452	456	460	464	468	472	476	480	0.80
0.79	237	241	245	249	253	257	261	265	269	273	277	280	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	359	363	367	371	375	379	383	387	391	395	399	403	407	411	415	419	423	427	431	435	438	442	446	450	454	458	462	466	470	474	0.79
0.78	234	238	242	246	250	254	257	261	265	269	273	277	281	285	289	293	296	300	304	308	312	316	320	324	328	332	335	340	343	347	351	355	359	363	367	371	374	378	382	386	390	394	398	402	406	410	413	417	421	425	429	433	437	441	445	449	452	456	460	464	468	0.78
0.77	231	234	239	243	246	250	254	258	262	266	270	273	277	281	285	289	293	296	300	304	308	312	316	320	323	327	331	335	339	343	347	350	354	358	362	366	370	373	377	381	385	389	393	397	400	404	408	412	416	420	424	427	431	435	439	443	447	450	454	458	462	0.77
0.76	228	232	236	239	243	247	251	255	258	262	266	270	274	277	281	285	289	293	296	300	304	308	312	315	319	323	327	331	334	338	342	346	350	353	357	361	365	369	372	376	380	384	388	391	395	399	403	407	410	414	418	422	426	429	433	437	441	445	448	452	456	0.76
0.75	225	229	233	236	240	244	248	251	255	259	263	266	270	274	278	281	285	289	293	296	300	304	308	311	315	319	323	326	330	334	338	341	345	349	353	356	360	364	368	371	375	379	383	386	390	394	398	401	405	409	413	416	420	424	428	431	435	439	443	446	450	0.75
0.74	222	226	229	233	237	241	244	248	252	255	259	263	266	270	274	278	281	285	289	292	296	300	303	307	311	315	318	322	326	329	333	337	340	344	348	352	355	359	363	366	370	374	377	381	385	389	392	396	400	403	407	411	414	418	422	426	429	433	437	440	444	0.74
0.73	219	223	226	230	234	237	241	245	248	252	256	259	263	266	270	274	277	281	285	288	292	296	299	303	307	310	314	318	321	325	329	332	336	339	343	347	350	354	358	361	365	369	372	376	380	383	387	391	394	398	402	405	409	412	416	420	423	427	431	434	438	0.73
0.72	216	220	223	227	230	234	238	241	245	248	252	256	259	263	266	270	274	277	281	284	288	292	295	299	302	306	310	313	317	320	324	328	331	335	338	342	346	349	353	356	360	364	367	371	374	378	382	385	389	392	396	400	403	407	410	414	418	421	425	428	432	0.72
0.71	213	217	220	224	227	231	234	238	241	245	249	252	256	259	263	266	270	273	277	280	284	288	291	295	298	302	305	309	312	316	320	323	327	330	334	337	341	344	348	351	355	359	362	366	369	373	376	380	383	387	391	394	398	401	405	408	412	415	419	422	426	0.71
0.70	210	214	217	221	224	228	231	235	238	242	245	249	252	256	259	263	266	270	273	277	280	284	287	291	294	298	301	305	308	312	315	319	322	326	329	333	336	340	343	347	350	354	357	361	364	368	371	375	378	382	385	389	392	396	399	403	406	410	413	417	420	0.70
0.69	207	210	214	217	221	224	228	231	235	238	242	245	249	252	255	259	262	266	269	273	276	279	283	286	290	293	297	300	304	307	311	314	317	321	324	328	331	335	338	342	345	348	352	355	359	362	366	369	373	376	380	383	386	390	393	397	400	404	407	411	414	0.69
0.68	204	207	211	214	218	221	224	229	231	235	238	241	245	248	252	255	258	262	265	269	272	275	279	282	286	289	292	296	299	303	306	309	313	316	320	323	326	330	333	337	340	343	347	350	354	357	360	364	367	371	374	377	381	384	388	391	394	398	401	405	408	0.68
0.67	201	204	208	211	214	218	221	224	229	231	235	239	241	245	248	251	255	258	261	265	268	271	275	278	281	285	288	291	295	298	302	305	308	312	315	318	322	325	328	332	335	338	342	345	348	352	355	358	362	365	369	372	375	379	382	385	389	392	395	399	402	0.67
0.66	198	201	205	208	211	215	218	221	224	228	231	234	238	241	244	248	251	254	257	261	264	267	271	274	277	281	284	287	290	294	297	300	304	307	310	314	317	320	323	327	330	333	337	340	343	347	350	353	356	360	363	366	370	373	376	380	383	386	389	393	396	0.66
0.65	195	198	202	205	208	211	215	218	221	224	228	231	234	237	241	244	247	250	254	257	260	263	267	270	273	276	280	283	287	289	293	296	299	302	306	309	312	315	319	322	325	328	332	335	338	341	345	348	351	354	358	361	364	367	371	374	377	380	384	387	390	0.65
0.64	192	195	198	202	205	208	211	214	218	221	224	227	230	234	237	240	243	246	250	253	256	259	262	266	269	272	275	278	283	285	288	291	294	298	301	304	307	310	314	317	320	323	326	330	333	336	339	342	346	349	352	355	358	362	365	368	371	374	378	381	384	0.64
0.63	189	192	195	198	202	205	208	211	214	217	221	224	227	230	233	236	239	243	246	249	252	255	258	261	265	268	271	274	277	280	284	287	290	293	296	299	302	306	308	312	315	318	321	324	328	331	334	337	340	343	347	350	353	356	359	362	365	369	372	375	378	0.63
0.62	186	189	192	195	198	202	205	208	211	214	217	220	223	226	229	233	236	239	242	245	248	251	254	257	260	264	267	270	273	276	279	282	285	288	291	295	298	301	304	307	310	313	316	319	322	326	329	332	335	338	341	344	347	350	353	357	360	363	366	369	372	0.62
0.61	183	186	189	192	195	198	201	204	207	210	214	217	220	223	226	229	232	235	238	241	244	247	250	253	256	259	262	265	268	271	275	278	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	336	339	342	345	348	351	354	357	360	363	366	0.61
0.60	180	183	186	189	192	195	198	201	204	207	210	213	216	219	222	225	228	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	357	360	0.60
	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595	600	

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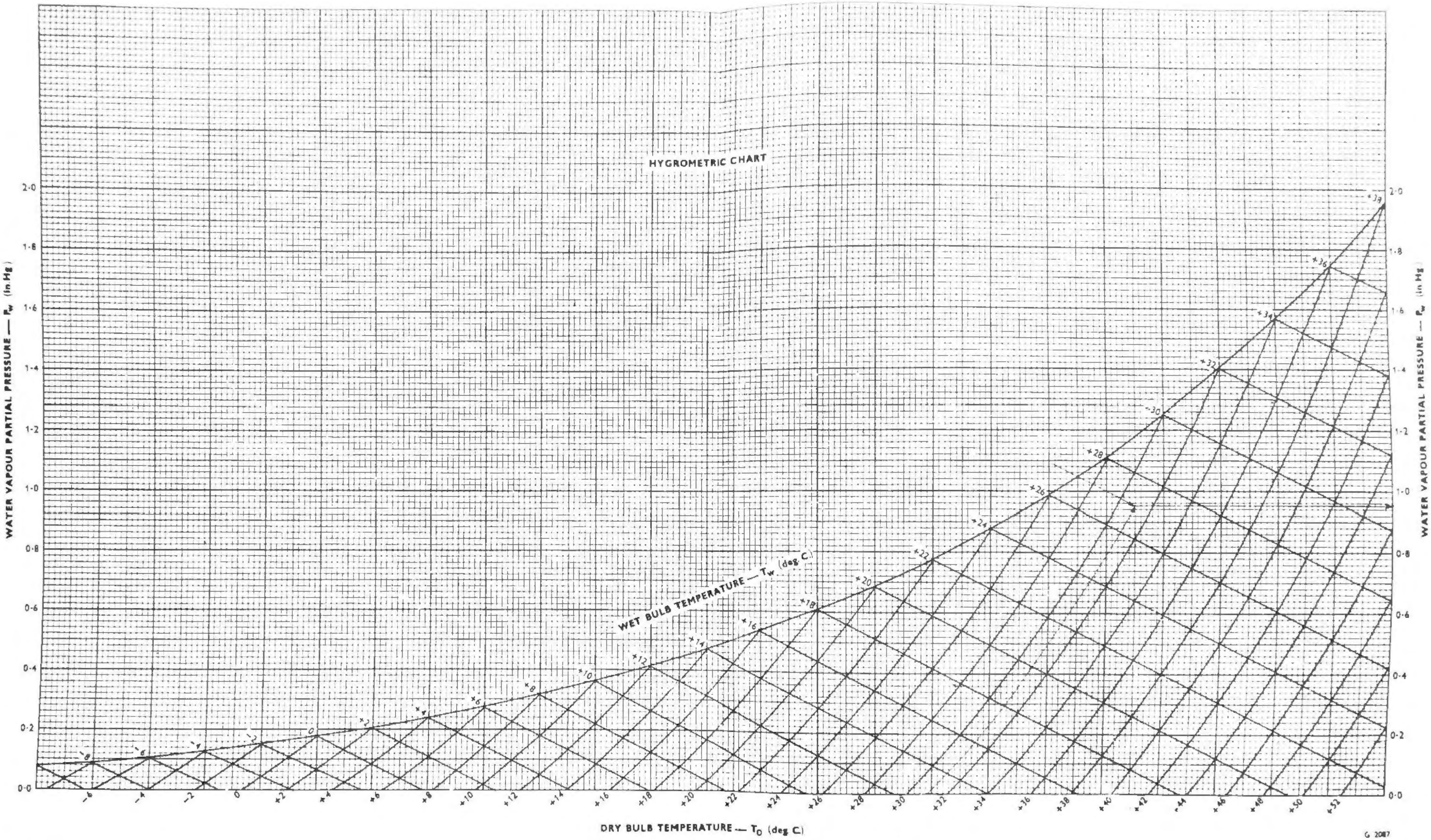
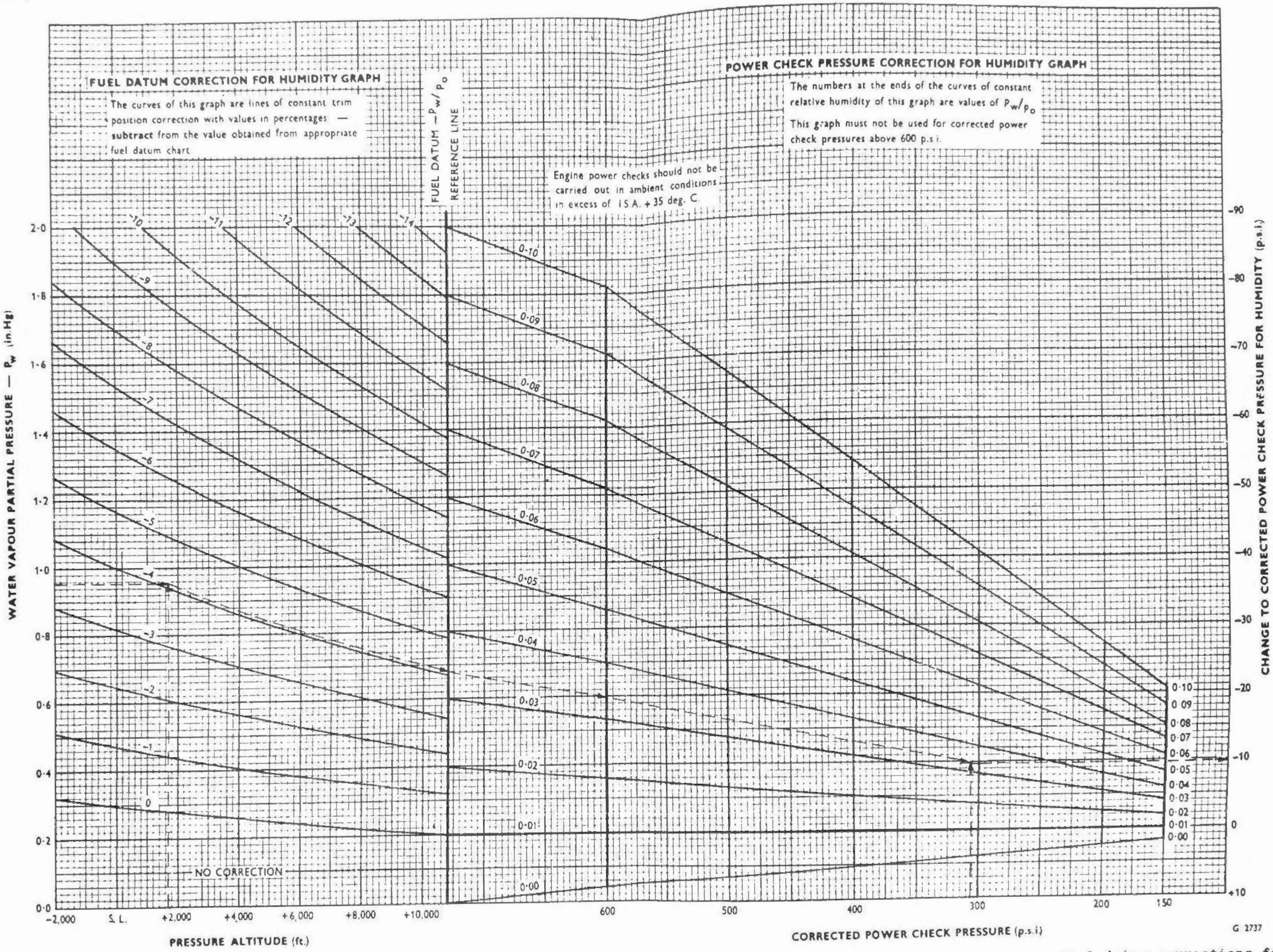
NOTE: Graphical representations of this table are shown in Fig.4-49 (full range) and Fig.4-50 (reduced range).

Corrections to Power Check Pressure - tabular
Figure 4-52



Hygrometric chart - graphical
Figure 4-53

NOTE: A tabular representation of this graph is shown in Fig.4-55.



Fuel datum corrections for humidity and change to corrected Power Check Pressure for humidity - graphical
Figure 4-54

NOTE: A tabular representation of this graph is shown in Fig. 4-56, 4-57 and 4-58.

HYGROMETRIC CHART

DRY BULB TEMPERATURE - T_O (deg.C.) (rows) / WET BULB TEMPERATURE - T_W (deg.C.) (columns)

T_O \ T_W	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	+13
+31																								0.02
+30																								0.04
+29																							0.01	0.07
+28																							0.04	0.09
+27																						0.01	0.06	0.11
+26																						0.03	0.08	0.14
+25																					0.01	0.06	0.11	0.16
+24																					0.03	0.09	0.13	0.18
+23																				0.01	0.06	0.10	0.15	0.21
+22																				0.03	0.08	0.13	0.18	0.23
+21																			0.01	0.06	0.10	0.15	0.20	0.25
+20																			0.03	0.08	0.13	0.17	0.22	0.28
+19																		0.01	0.06	0.10	0.15	0.20	0.25	0.30
+18																		0.04	0.08	0.13	0.17	0.22	0.27	0.33
+17																	0.02	0.06	0.10	0.15	0.20	0.25	0.30	0.35
+16																	0.04	0.08	0.13	0.17	0.22	0.27	0.32	0.37
+15																0.02	0.07	0.11	0.15	0.20	0.25	0.29	0.34	0.40
+14																0.04	0.09	0.13	0.17	0.22	0.27	0.32	0.37	0.42
+13															0.03	0.07	0.11	0.15	0.20	0.25	0.29	0.34	0.39	0.44
+12														0.01	0.05	0.09	0.14	0.18	0.22	0.27	0.32	0.36	0.41	
+11														0.04	0.07	0.12	0.16	0.20	0.25	0.29	0.34	0.39		
+10													0.02	0.06	0.10	0.14	0.18	0.22	0.27	0.32	0.36			
+9												0.01	0.04	0.08	0.12	0.16	0.20	0.25	0.29	0.34				
+8												0.03	0.07	0.11	0.15	0.19	0.23	0.27	0.32					
+7											0.02	0.05	0.09	0.13	0.17	0.21	0.25	0.30						
+6										0.02	0.04	0.08	0.12	0.15	0.19	0.23	0.28							
+5										0.04	0.06	0.10	0.14	0.18	0.22	0.26								
+4									0.03	0.06	0.09	0.12	0.16	0.20	0.24									
+3								0.01	0.05	0.08	0.11	0.15	0.19	0.22										
+2								0.03	0.07	0.10	0.13	0.17	0.21											
+1							0.02	0.06	0.09	0.12	0.16	0.20												
0						0.01	0.04	0.08	0.11	0.15	0.18													
-1						0.03	0.07	0.10	0.13	0.17														
-2					0.02	0.06	0.09	0.12	0.15															
-3				0.02	0.04	0.08	0.11	0.14																
-4			0.01	0.04	0.07	0.10	0.13																	
-5			0.03	0.06	0.09	0.12																		
-6		0.02	0.05	0.08	0.11																			
-7	0.01	0.04	0.07	0.10																				
-8	0.04	0.06	0.09																					
-9	0.06	0.08																						
-10	0.08																							

T_O \ T_W	+14	+15	+16	+17	+18	+19	+20	+21	+22	+23	+24	+25	+26	+27	+28	+29	+30	+31	+32	+33	+34	+35	+36	+37	+38
+50								0.05	0.12	0.19	0.27	0.35	0.43	0.51	0.60	0.69	0.78	0.88	0.98	1.08					
+49							0.01	0.07	0.15	0.22	0.29	0.37	0.45	0.53	0.62	0.71	0.80	0.90	1.00	1.11					
+48							0.03	0.10	0.17	0.24	0.32	0.39	0.47	0.56	0.64	0.74	0.83	0.92	1.03	1.13					
+47							0.05	0.12	0.19	0.26	0.34	0.42	0.50	0.58	0.67	0.76	0.85	0.95	1.05	1.16	1.28	1.38	1.49	1.62	1.75
+46						0.01	0.08	0.15	0.22	0.29	0.36	0.44	0.52	0.61	0.69	0.78	0.87	0.97	1.08	1.18	1.29	1.40	1.52	1.64	1.77
+45						0.04	1.10	0.17	0.24	0.31	0.38	0.46	0.54	0.63	0.72	0.81	0.90	1.00	1.10	1.20	1.31	1.42	1.54	1.67	[illegible]
+44						0.08	0.12	0.19	0.26	0.33	0.41	0.49	0.57	0.65	0.74	0.83	0.92	1.02	1.12	1.23	1.34	1.45	1.57	1.69	1.82
+43					0.02	0.08	0.15	0.22	0.28	0.36	0.43	0.51	0.59	0.68	0.76	0.85	0.95	1.04	1.15	1.25	1.36	1.47	1.59	1.71	[illegible]
+42					0.04	0.11	0.17	0.24	0.31	0.38	0.46	0.53	0.61	0.70	0.79	0.88	0.97	1.07	1.17	1.27	1.38	1.49	1.61	1.74	1.86
+41				0.01	0.07	0.13	0.20	0.26	0.33	0.41	0.48	0.56	0.64	0.72	0.81	0.90	0.99	1.09	0.19	1.30	1.41	1.52	1.64	1.76	1.89
+40				0.03	0.09	0.15	0.22	0.29	0.35	0.43	0.50	0.58	0.66	0.75	0.84	0.92	1.02	1.11	1.22	1.32	1.43	1.54	1.66	1.78	1.91
+39				0.05	0.11	0.18	0.24	0.31	0.38	0.45	0.53	0.61	0.69	0.77	0.86	0.95	1.04	1.14	1.24	1.34	1.45	1.57	1.68	1.81	1.93
+38			0.02	0.08	0.14	0.20	0.27	0.33	0.40	0.48	0.55	0.63	0.71	0.79	0.88	0.97	1.06	1.16	1.26	1.37	1.48	1.59	1.71	1.83	1.96
+37			0.04	0.10	0.16	0.22	0.29	0.36	0.43	0.50	0.57	0.65	0.73	0.82	0.90	1.00	1.09	1.18	1.29	1.39	1.50	1.61	1.73	1.85	
+36		0.01	0.07	0.12	0.18	0.25	0.31	0.38	0.45	0.52	0.60	0.68	0.76	0.84	0.93	1.02	1.11	1.21	1.31	1.41	1.52	1.64	1.75		
+35		0.03	0.09	0.15	0.21	0.27	0.34	0.41	0.47	0.55	0.62	0.70	0.78	0.87	0.95	1.04	1.13	1.23	1.34	1.44	1.55	1.66			
+34		0.06	0.11	0.17	0.23	0.30	0.36	0.43	0.50	0.57	0.64	0.72	0.80	0.89	0.97	1.07	1.16	1.26	1.36	1.46	1.57				
+33	0.02	0.08	0.14	0.20	0.25	0.32	0.38	0.45	0.52	0.59	0.67	0.75	0.83	0.91	1.00	1.09	1.18	1.28	1.38	1.49					
+32	0.05	0.10	0.16	0.22	0.28	0.34	0.41	0.48	0.54	0.62	0.69	0.77	0.85	0.94	1.02	1.11	1.21	1.30	1.40						
+31	0.07	0.13	0.18	0.24	0.30	0.37	0.43	0.50	0.57	0.64	0.72	0.79	0.87	0.96	1.05	1.14	1.23	1.33							
+30	0.09	0.15	0.21	0.27	0.33	0.39	0.46	0.52	0.59	0.66	0.74	0.82	0.90	0.98	1.07	1.16	1.25								
+29	0.12	0.17	0.23	0.29	0.35	0.41	0.48	0.55	0.61	0.69	0.76	0.84	0.92	1.00	1.09	1.18									
+28	0.14	0.20	0.25	0.31	0.37	0.44	0.50	0.57	0.64	0.71	0.79	0.87	0.95	1.03	1.12										
+27	0.17	0.22	0.28	0.34	0.40	0.46	0.53	0.59	0.66	0.74	0.81	0.89	0.97	1.05											
+26	0.19	0.25	0.30	0.36	0.42	0.48	0.55	0.62	0.69	0.76	0.83	0.91	0.99												
+25	0.21	0.27	0.33	0.38	0.44	0.51	0.57	0.64	0.71	0.78	0.86	0.94													
+24	0.24	0.29	0.35	0.41	0.47	0.53	0.60	0.66	0.73	0.81	0.86														
+23	0.26	0.32	0.37	0.43	0.49	0.56	0.62	0.69	0.76	0.83															
+22	0.28	0.34	0.40	0.45	0.51	0.58	0.64	0.71	0.78																
+21	0.31	0.36	0.42	0.48	0.54	0.60	0.67	0.74																	
+20	0.33	0.38	0.44	0.50	0.56	0.63	0.70																		
+19	0.35	0.41	0.47	0.53	0.59	0.65																			
+18	0.38	0.43	0.49	0.55	0.61																				
+17	0.40	0.46	0.51	0.57																					
+16	0.43	0.48	0.54																						
+15	0.45	0.50																							
+14	0.47																								

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Hygrometric chart - tabular
Figure 4-55

WET BULB TEMPERATURE - T_W (deg.C.)

NOTE: A graphical representation of this table is shown in Fig.4-53.

FUEL DATUM CORRECTIONS FOR HUMIDITY TABLE

WATER VAPOUR PARTIAL PRESSURE – p_w (in. Hg.) vs. PRESSURE ALTITUDE (ft.)

WATER VAPOUR PARTIAL PRESSURE – p_w (in. Hg.)	-1,000	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	WATER VAPOUR PARTIAL PRESSURE – p_w (in. Hg.)
2.00	- 9	-10	-10	-10	-11	-11	-12	-12	-12	-12	-13	-14	2.00
1.90	- 9	- 9	- 9	-10	-10	-11	-11	-11	-12	-12	-13	-13	1.90
1.80	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	-12	-12	-13	1.80
1.70	- 8	- 8	- 8	- 9	- 9	- 9	-10	-10	-11	-11	-11	-12	1.70
1.60	- 7	- 7	- 8	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	1.60
1.50	- 7	- 7	- 7	- 7	- 8	- 8	- 9	- 9	- 9	-10	-10	-11	1.50
1.40	- 6	- 6	- 7	- 7	- 7	- 8	- 8	- 8	- 9	- 9	- 9	-10	1.40
1.30	- 6	- 6	- 6	- 6	- 7	- 7	- 7	- 8	- 8	- 8	- 9	- 9	1.30
1.20	- 5	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 7	- 7	- 8	- 8	1.20
1.10	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 6	- 7	- 7	- 7	1.10
1.00	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 7	1.00
0.90	- 3	- 3	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 5	- 6	0.90
0.80	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	- 4	- 5	- 5	0.80
0.70	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	0.70
0.60	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	0.60
0.50	- 1	- 1	- 1	- 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 2	0.50
0.40	0	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 2	- 2	0.40
0.30		0	0	0	0	0	0	0	- 1	- 1	- 1	- 1	0.30
0.20									0	0	0	0	0.20
0.10	NO CORRECTION												0.10
0.00													0.00

PRESSURE ALTITUDE (ft.)

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Fuel datum corrections for humidity - tabular
Figure 4-56

NOTE: A graphical representation of this table is shown in Fig. 4-54.

RELATIVE HUMIDITY (P_W/P_O) FACTOR TABLE

WATER VAPOUR PARTIAL PRESSURE - P_w (in. Hg.)

P_w	-1,000	- 500	S.L.	+ 500	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	P_w
2.00	0.064	0.065	0.067	0.068	0.069	0.072	0.074	0.077	0.080	0.083	0.086	0.090	0.093	0.097	2.00
1.90	0.061	0.062	0.063	0.064	0.066	0.068	0.071	0.073	0.076	0.079	0.082	0.085	0.089	0.092	1.90
1.80	0.058	0.059	0.060	0.061	0.062	0.065	0.067	0.069	0.072	0.075	0.078	0.081	0.084	0.087	1.80
1.70	0.055	0.056	0.057	0.058	0.059	0.061	0.063	0.066	0.068	0.071	0.073	0.076	0.079	0.082	1.70
1.60	0.051	0.052	0.053	0.054	0.055	0.057	0.060	0.062	0.064	0.067	0.069	0.072	0.075	0.078	1.60
1.50	0.048	0.049	0.050	0.051	0.052	0.054	0.056	0.058	0.060	0.062	0.065	0.067	0.070	0.073	1.50
1.40	0.045	0.046	0.047	0.048	0.048	0.050	0.052	0.054	0.056	0.058	0.060	0.063	0.065	0.068	1.40
1.30	0.042	0.043	0.044	0.044	0.045	0.047	0.048	0.050	0.052	0.054	0.056	0.058	0.061	0.063	1.30
1.20	0.039	0.040	0.041	0.041	0.041	0.043	0.045	0.046	0.048	0.050	0.052	0.054	0.056	0.058	1.20
1.10	0.035	0.036	0.037	0.037	0.038	0.039	0.041	0.042	0.044	0.046	0.048	0.049	0.051	0.053	1.10
1.00	0.032	0.033	0.033	0.034	0.035	0.036	0.037	0.039	0.040	0.042	0.043	0.045	0.047	0.048	1.00
0.90	0.029	0.029	0.030	0.031	0.031	0.032	0.033	0.035	0.036	0.037	0.039	0.040	0.042	0.044	0.90
0.80	0.026	0.026	0.027	0.027	0.028	0.029	0.030	0.031	0.032	0.033	0.035	0.036	0.037	0.039	0.80
0.70	0.023	0.023	0.023	0.024	0.024	0.025	0.026	0.027	0.028	0.029	0.030	0.031	0.033	0.034	0.70
0.60	0.019	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.025	0.026	0.027	0.028	0.029	0.60
0.50	0.016	0.016	0.017	0.017	0.017	0.018	0.019	0.019	0.020	0.021	0.022	0.022	0.023	0.024	0.50
0.40	0.013	0.013	0.013	0.014	0.014	0.014	0.015	0.015	0.016	0.017	0.017	0.018	0.019	0.019	0.40
0.30	0.010	0.010	0.010	0.010	0.010	0.011	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.015	0.30
0.20	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.009	0.009	0.009	0.010	0.20
0.10	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.10
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00

PRESSURE ALTITUDE (ft.)

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Relative humidity factors - tabular

Figure 4-57

<u>NOTE:</u> A graphical representation of this table is shown in Fig. 4-54

CHANGE TO CORRECTED POWER CHECK PRESSURE FOR HUMIDITY TABLE

RELATIVE HUMIDITY – P_w/P_o	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	RELATIVE HUMIDITY – P_w/P_o
0.100	-27	-30	-32	-35	-38	-40	-43	-46	-48	-51	-54	-56	-59	-62	-64	-67	-70	-73	-75	-78	-81	0.100
0.095	-25	-28	-30	-33	-35	-38	-40	-43	-45	-48	-50	-53	-55	-58	-60	-63	-65	-68	-71	-73	-76	0.095
0.090	-24	-26	-28	-31	-33	-35	-38	-40	-42	-45	-47	-49	-52	-54	-56	-59	-61	-64	-66	-68	-71	0.090
0.085	-22	-24	-26	-28	-31	-33	-35	-37	-39	-42	-44	-46	-48	-50	-53	-55	-57	-59	-61	-64	-66	0.085
0.080	-20	-22	-24	-26	-28	-30	-32	-34	-37	-39	-41	-43	-45	-47	-49	-51	-53	-55	-57	-59	-61	0.080
0.075	-19	-21	-22	-24	-26	-28	-30	-32	-34	-36	-37	-39	-41	-43	-45	-47	-49	-51	-52	-54	-56	0.075
0.070	-17	-19	-21	-22	-24	-26	-27	-29	-31	-33	-34	-36	-38	-39	-41	-43	-45	-46	-48	-50	-51	0.070
0.065	-16	-17	-19	-20	-22	-23	-25	-27	-28	-30	-31	-33	-34	-36	-37	-39	-41	-42	-44	-45	-47	0.065
0.060	-14	-15	-17	-18	-20	-21	-23	-24	-25	-27	-28	-30	-31	-32	-34	-35	-37	-38	-39	-41	-42	0.060
0.055	-13	-14	-15	-16	-18	-19	-20	-21	-23	-24	-25	-26	-28	-29	-30	-31	-33	-34	-35	-37	-38	0.055
0.050	-11	-12	-13	-14	-16	-17	-18	-19	-20	-21	-22	-23	-25	-26	-27	-28	-29	-30	-31	-32	-33	0.050
0.045	-10	-11	-12	-13	-14	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25	-26	-27	-28	-29	0.045
0.040	- 8	- 9	-10	-11	-12	-12	-13	-14	-15	-16	-16	-17	-18	-19	-20	-21	-21	-22	-23	-24	-25	0.040
0.035	- 7	- 7	- 8	- 9	-10	-10	-11	-12	-12	-13	-14	-14	-15	-16	-16	-17	-18	-18	-19	-20	-20	0.035
0.030	- 5	- 6	- 6	- 7	- 8	- 8	- 9	- 9	-10	-10	-11	-11	-12	-12	-13	-14	-14	-15	-15	-16	-16	0.030
0.025	- 4	- 4	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 8	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	-12	-12	0.025
0.020	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 7	- 7	- 8	- 8	0.020
0.015	- 1	- 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	0.015
0.010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.010
0.005	+ 1	+ 1	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 4	+ 4	+ 4	+ 4	0.005
0.000	+ 3	+ 3	+ 3	+ 3	+ 4	+ 4	+ 4	+ 4	+ 5	+ 5	+ 5	+ 5	+ 6	+ 6	+ 6	+ 6	+ 6	+ 7	+ 7	+ 8	+ 8	0.000

CORRECTED POWER CHECK PRESSURE (p.s.i.)

G2092A

Change to corrected Power Check Pressure for humidity - tabular
Figure 4-58

NOTE: A graphical representation of this graph is shown in Fig. 4-54.

Reserved

4.9.6 Engine Starting and Run-up Procedures

4.9.6.1 External Check

1. Area & Equipment ....CLEAR

2. Chock ....CHECK

3. Ground Fire Extinguisher ....READY

4. Landing Gear Safety Pin ....IN

5. Aircraft Position ....CHECK (Cross Wind ± 30°)

6. Nose L/G Bay
   (1) Nose L/G & Door ....CHECK
   (2) Torque Arm Pin ....CONNECTED
   (3) Tire & Oleo ....CHECK

7. Front Fuselage
   (4) Access Door ....LOCKED
   (5) Pitot Tube & Cover ....CHECK
   (6) Static Pressure Port ....CLEAR
   (7) Antennas & Anticollision Light ....CHECK

8. R/H. Nacelle & Propeller
   (8) Engine Air Intake Cowling ....CHECK & NO COVER
   (9) Propeller Blade ....CHECK
   (10) Propeller Angle ...."0" DEGREE
   (11) Propeller Rotation ....FREE
   (12) Fire Extinguisher Indicator ....CHECK (Green)
   (13) Engine Cowling.....................SECURE
   (14) Engine Exhaust Pipe ....CHECK & NO COVER
   (15) Fuel & Oil Leak ....NO LEAK

9. R/H. Main Wheel Well
   (16) Main L/G & Door ....CHECK
   (17) Tire & Oleo ....CHECK
   (18) Wing De-ice Fire Extinguisher
        Indicator ....CHECK (Yellow)

10. R/H. Wing
    (19) Wing Heater Inlet Duct ....CHECK
    (20) Wing Leading Edge ....CHECK
    (21) Wing Lower Surface ....CHECK & NO FUEL LEAKAGE
    (22) Navigation Light ....CHECK
    (23) Static Discharger ....CHECK
    (24) Aileron & Tab ....CHECK NEUTRAL
    (25) Flaps ....CHECK (Up)

11. Horizontal & Vertical Tail
    (26) Stabilizer & Vortex Generator .....CHECK
    (27) Elevator & Tabs ....NEUTRAL
    (28) Vertical Stabilizer ....CHECK

(29) Rudder & Tab .... NEUTRAL
(30) Antennas .... CHECK
(31) Tail Navigation Light .... CHECK

12. L/H. Nacelle & Propeller
(32) Engine Air Intake Cowling .... CHECK & NO COVER
(33) Propeller Blade .... CHECK
(34) Propeller Angle .... "O" DEGREE
(35) Propeller Rotation .... FREE
(36) Fire Extinguisher Indicator .... CHECK (Green)
(37) Engine Cowling .... SECURE & NO COVER
(38) Engine Exhaust Pipe .... CHECK & NO COVER
(39) Fuel & Oil Leak .... NO LEAK

13. L/H. Wing
(40) Wing Heater Inlet Duct .... CHECK
(41) Wing Leading Edge .... CHECK
(42) Wing Lower Surface .... CHECK & NO FUEL, W/M LEAK
(43) Navigation Light .... CHECK
(44) Static Discharger .... CHECK
(45) Aileron & Tab .... CHECK NEUTRAL
(46) Flaps .... CHECK (Up)

14. Prepare records and engine data necessary for the engine run up.

4.9.6.2 Cockpit Check

4.9.6.2.1 Before Starting Check (External Power Off)

1. Circuit Breaker Panels .... 3 PANELS CHECK

2. Battery Sw .... OFF

3. Windshield De-ice Sw (LH, RH) .... OFF

4. Pitot Deicing Heater Sw .... OFF

5. Wing Tail De-ice & Ignition Select Sw(3). OFF

6. Ram Air Override Sw. .... NORMAL

7. Blower Sw .... OFF

8. Ignition Test Sw .... NORMAL

9. Aircraft De-icing Sw.................... OFF

10. Engine De-icing Master Sw.(Nos. 1&2)..... OFF

11. Radio Power Feed Master Sw. & Cooling
Fan Sw. .... OFF

12. Generator Sw. (Nos. 1 & 2) .... OFF

13. Scavenge Pump Sw. (Nos. 1 & 4)....... OFF

14. Booster Pump Sw. (Nos. 1 & 4, Main Emerg.) .... OFF

15. Crossfeed Valve Sw. .... NORMAL

16. Fuel De-icing Sw. (Nos. 1 & 2)....... OFF

17. Inverter Sw. (C.F. Power Source) Nos. 1 & 2, Emerg. .... OFF

18. Alternator Sw. (W.F. Power Source) Nos. 1 & 2 .... OFF

19. W.F. Alternator Transfer Sw. Nos. 1 & 2 .... OFF

20. Landing Light & Motor Sw. .... OFF

21. Taxi Light Sw. .... OFF

22. Wing Inspection Light Sw. .... OFF

23. Anti Collision Light Sw. .... OFF

24. Navigation Light Sw................. OFF

25. Starter Master Sw. .... SAFE

26. Engine Selector Sw .... OFF

27. Ign. Relight Sw. (Nos. 1 & 2) .... OFF

28. Wing Fire Extinguisher Sw. (LW. Tail, RW) .... OFF

29. High Stop Sw. .... NORMAL

30. Emerg.Fuel Shut Off Handle (Nos. 1 & 2) .... LOCK

31. Fire Extinguisher Discharge Sw...... CHECK (Off)

32. Propeller Brake Sw. .... OFF

33. Wiper Speed Control Knob .... FULL CLOSE (C.W)

34. Oxygen Supply Sw. .... OFF

35. Static Selector Sw. (2) .... NORMAL

36. Anti Skid Sw. .... OFF

37. Parking Brake Handle .... PULL SET

38. Landing Gear Handle .... DOWN

39. Fuel Qty Test Selector Sw. (LH,RH). MAIN SELECTED

40. Emerg.Hyd. Pump Sw .... OFF

41. Emerg.L/G Handle .... LOCK

42. Cooling Fan Sw. .... OFF

43. Spill Valve Sw. (LH, RH) .... MANUAL

44. By-Pass Handle .... BY-PASS

45. Cockpit Temp.Selector Knob .... OFF

46. Emerg.Flap Handle .... LOCKED

47. Manual Cont.Knob .... FULL INC.

48. Press. Cont. Shut Off Sw. .... OPEN

49. Pitot Static Shut Off Valve .... NORMAL

50. All Trim Tabs (3) .... NEUTRAL CHECK

51. Prop. Synchro Sw. .... OFF

52. W/M Booster Pump Sw. .... OFF

53. W/M Master Sw. (LH, RH) .... OFF

54. Flap Cont. Sw. .... OFF

55. Gust Lock Lever .... LOCK

56. H.P. Cock Lever (Nos. 1 & 2) ...... OFF

57. Low Stop Lever .... GROUND

58. Throttle Lever (Nos. 1 & 2) .... FULL MIN

59. Friction Lock Lever .... UNLOCK

60. Emerg.Brake Handle .... NORMAL (Push)

61. Stewardess Circuit Panel Sw. ...... OFF

4.9.c.2 External Power on Check

1. External Power .... CONNECT

2. Battery Sw. .... EXTERNAL

3. External Power I/C .... ON

4. DC Voltage .... CHECK (28V ± [illegible])

5. Battery 24V

    (1) Emer. Shut off Valve Ind.
        (LH, RH) .... OPEN
    (2) Fuel Cross Feed Ind. (LH,RH).. SHUT
    (3) Main Bus Fail W/L .... ON
    (4) Alternator Fail W/L
        (Nos. 1 & 2) .... ON
    (5) Power Fail W/L (Nos. 1 & 2)... ON
    (6) Fuel Press W/L (Nos. 1 & 2)... ON
    (7) Oil Press W/L (Nos. 1 & 2).... ON
    (8) Landing Gear I/L & Unlock I/L. ON 3 GREEN & OFF
    (9) Low Stop Unsafe Light .... ON
    (10) Below Low Stop Light
        (Nos. 1 & 2) .... ON
    (11) Feathering Pump Light
        (Nos. 1 & 2) .... OFF
    (12) High Stop Removed Light
        (Nos. 1 & 2) .... OFF (Push to Test)
    (13) High Stop Unsafe Light .... ON
    (14) High Stop Emerg. Sw. .... CHECK NORMAL

6. Inverter Sw. (Nos. 1 or 2)........ ON

7. Power Fail W/L (Nos. 1 & 2)....... OFF

8. Eng. Overheat Test Button
    (Nos. 1 & 2) .... PUSH TO TEST

9. Eng. Overheat (Nos. 1 & 2)........ PUSH TO TEST

10. L/G Fire W/L (Nos. 1 & 2) .... PUSH TO TEST

11. Engine Oil Temp. Ind.(Nos. 1&2)... CHECK

12. Flap Position Ind. .... UP

13. Fuel Quantity, (Nos. 1 & 4) ...... CHECK (Min. 1000 lbs)

14. W/M Qty Ind. .... CHECK (Min. 40 USG)

15. Hyd. Qty Ind. .... CHECK (In Green Marks)

16. Hyd. Press. Normal .... CHECK (2100 psi above)
Emerg. .... CHECK (2400 psi above)

17. Emerg. Hyd. Press. Sw. .... NORMAL

18. Under Floor Door Open W/L .... OFF (Push to Test)

19. Cabin Door Open W/L .... OFF (Push to Test)

20. Spill Valve Light (LH, RH) .... ON

21. W/M Pressure Light (LH, RH) .... OFF

4.9.6.4 Starting Procedures

1. Door Warning Light .... OFF

2. Anti-collision Light .... ON

3. Fuel Trimmer Sw. .... O.A.T. SET

NOTE: Outside air temperature + 10°C above 10%
Outside air temperature + 10°C below 30%

4. Check Oil Temp. .... MIN. -30°C
(Minimum for Open Up -15°C)

5. H. P. Cock Lever .... OFF

6. Low Stop Lever .... GROUND

7. Throttle Lever .... FULL MIN.

8. Fuel Booster Pump .... ON

9. Fuel Pressure W/L .... OFF

10. Propeller Brake Sw. .... OFF
(After Stair Way Up)

11. Engine Selector Sw. .... #2 SELECT

12. Starter Master Sw. .... START

13. Propeller Stop .... CHECK

14. Check Fire Guard .... CLEAR

15. Starter Push Button .... 2 to 3 SEC. PUSH

16. Starter Motor I/L .... #2 ON

17. H.P Cock Lever .... H.S.W.D. (Lock Out)

When Engine Speed Reaches 1200 to 1500 rpm

18. High Stop Removed Light .... ON

19. Start T.G.T. .... WATCH NOT TO EXCEED 930°C

20. Oil Pressure W/L .... 5 to 6 psi OFF

21. Oil Pressure Gauge .... CHECK OFF
STOP

22. Start Push Button (After 30 Second) POP OUT
Starter Motor Indicator Light ..... OFF

23. Fuel Trimmer .... O.A.T. SET

<u>CAUTION</u>: DISCONTINUE THE ENGINE STARTING IMMEDIATELY (POSITIONING THE ENGINE SELECTOR SWITCH TO SAFE) AND PLACE THE H.P. COCK LEVER IN FUEL OFF IF ANY OF THE FOLLOWING CONDITIONS TAKES PLACE:

1. No light up within 20 seconds after initial indication of fuel flow

2. T.G.T. approaches 930°C

3. No oil pressure indication

4. No automatic acceleration to idle rpm

5. Unusual or excessive propeller vibration.

<u>NOTE</u>: If starting is discontinued, motor the engine for 30 second and allow the fuel drain collector can to drain fuel for 2 min.

6. Increase the trimmer gradually, watching the T.G.T. indicator in order to avoid abrupt rise of T.G.T.

7. If the starter motor indicator light remains on, place the starter master switch in SAFE.

24. No. 1 Engine Select Sw. .... SELECT
(No. 2 Engine in the Same Manner)

4.9.6.5 After Start

1. Starter Master Switch .... SAFE

2. Engine Selector Switch .... OFF

3. Generator Switch (Nos 1 & 2) ...... ON

4. External I/L .... OFF

5. D.C. Voltage .... CHECK (28V ± 1V)
& Battery Voltage .... CHECK

6. Battery Switch .... BATTERY

7. External Power Unit .... DISCONNECTED & CLEARED

8. Hyd. By-pass Lever .... NORMAL

9. Hyd. Pressure .... 2575 to 3200 psi

4.9.6.6 Engine Serviceability Check

4.9.6.6.1 Idling Check

1. Throttle Lever .... MIN. POSITION

2. Set Fuel Trimmer .... FULL INCREASE

3. Check and Record rpm .... CHECK & RECORD (8000 to 85000 RPM)

4. Check and Record Fuel Flow .... CHECK & RECORD (345± 8lb/HR)

4.9.6.6.2 12000 R.P.M. Check

1. Set Fuel Trimmer .... O.A.T. SET

2. Set Engine RPM .... 12000 RPM.

3. Oil Pressure and Oil Temperature . CHECK & RECORD

NOTE: Minimum Oil Temperature .... 55°C
Minimum Oil Press .... 13.5 psi at 55°C
12.0 psi at 115 to 120°C

4. Fuel Heater De-icing Check
(1) Fuel Filter Heater Switch to Manual .... DECREASE 50~100 RPM
(2) Fuel Filter Heater Switch to Off .... INCREASE 50~100 RPM

5. Power Unit Ice Protection System Check
(1) Set Engine RPM 12000rpm
(2) Alternator Switch .... START-ON
(3) A.C. Voltage (144-156V) .... CHECK & RECORD
(4) Engine De-icing Timer Switch ... FAST -15°C ABOVE
SLOW -15°C BELOW

(5) Engine De-icing Master Switch .. ON FOR 5 SECS-THEN OFF
(6) Timer Fail I/L .... OFF
(7) De-icing Fail I/L .... OFF
(8) A.C. Ammeter .... CHECK/COMPLETE CYCLE
0 ~20 Seconds ......30~35 Amps ... AIR INTAKE
20~40 Seconds ......40~50 Amps ... PROPELLER & SPINNER
40~80 Seconds ...... 7~10 Amps ... AIR INTAKE CONTINUOUS

WARNING: When the outside air temperature is above 30°C, do not conduct the power unit ice protection system check. Operation in excess of 6 cycles is also prohibited.

(9) Alternator Switch .... OFF

(10) Alternator Failure I/L .... ON

4.9.6.6.3 Dry Power Check

1. Set Fuel Trimmer .... AMBIENT SET

2. Check Oil Temperature .... AT LEAST 55°C

3. Advance Throttle .... SMOOTHLY
   Below Low Stop Light .... OUT

NOTE: Keep the throttle lever in FULL OPEN position for 1 min 30 sec. at least to stabilize T.G.T.

4. Check and Record
   (1) Engine RPM .... 15000～15050 RPM
   (2) T.G.T. .... NOT TO EXCEED 865°C
   (3) Torque Press. .... RECORD
   (4) Engine Oil Pressure .... AT LEAST 13.5 psi
   (5) Engine Oil Temperature .... 65° ～ 75°C
   (6) Engine Fuel Flow .... RECORD

NOTE: 1. The maximum allowable T.G.T. while the throttle is in FULL OPEN position is 865°C.

2. Record the reading swiftly and accurately to minimize the engine ground run time at the maximum power condition.

(7) Retard Throttle Smoothly ...... BELOW LOW STOP LIGHT ON

4.9.6.6.4 Wet Power Check

1. Set Fuel Trimmer Ambient .... SET

2. Position Throttle .... MINIMUM

3. Check Oil Temperature .... AT LEAST 65°C

4. W/M Booster Pump Switch .... ON

5. W/M Master Sw. .... ON

6. W/M Pressure Indicator Light ...... ON

WARNING: Do not turn on the W/M booster pump switch and the W/M master switch at higher rpm (in excess of 14500 rpm).

7. Advance Throttle .... SMOOTHLY

NOTE: Advance the throttle lever smoothly up to 14000 rpm and, then, advance it slowly from 14000 rpm to 14700 rpm. Watching carefully the tachometer and the torque pressure indicator all the time, take a rest at 14700 rpm for 10 sec., then, advance to 14800 rpm and then, make sure that the torque pressure increases, watching the torque pressure indicator. Check that the W/M system cuts in at 14700 to 14900 rpm, increasing the torque pressure.

CAUTION: IF THE TORQUE PRESSURE DOES NOT INCREASE BEFORE THE ENGINE SPEED REACHES, CHECK THE SYSTEM.

8. After Increase in Torque Pressure, Advance Throttle to Take-off.

9. Check and Record Readings .... AT LEAST 60 SEC.

   (1) T.G.T. .... NOT EXCEED 890°C & RECORD
   (2) Torque Pressure .... CORRECTED DATA PLATE ..... RECORD WITHIN $^{+7}_{-0}$ PSI

CAUTION: 1. RECORD THE READING SWIFTLY AND ACCURATELY TO MINIMIZE THE ENGINE GROUND RUN TIME AT THE MAXIMUM POWER CONDITION.

2. WHEN THE THROTTLE IS RETARDED FROM THE FULL OPEN POSITION, TAKE AT LEAST 5 SEC BEFORE THE ENGINE SPEED REACHES 14500 RPM.

3. BE CAREFUL NOT TO RETARD THE THROTTLE ABRUPTLY, OTHERWISE THE T.G.T. MAY EXCEED 1000°C.

10. Retard Throttle to 14650 RPM ..... TAKING AT LEAST 15 SEC.
    Hold at 14650 RPM for 15 Sec. .... NO FALL IN TORQUE PRESSURE

11. W/M Cutout Check .... RECORD

12. W/M Booster Pump Switch .... OFF

13. W/M Master Switch .... OFF

14. W/M Pressure Indicator Light ..... OFF

15. Retard Throttle .... BELOW LOW STOP LIGHT ON

4.9.7 Engine Shut-Down Procedures

1. Low Stop Lever .... GROUND

2. Gust Lock Lever .... LOCK

3. Throttle Lever .... MINIMUM

4. Fuel Trimmer .... FULL DECREASE

5. H.P. Cock Lever .... FUEL OFF

6. Oil Pressure W/L .... ON

7. Propeller Brake Sw. .... ON BELOW 3000 RPM

8. D.C. Generator Sw. .... OFF

9. Inverter Sw. .... OFF

10. Fuel Booster Pump Sw. .... OFF

11. Anti Collision Light Sw. .... OFF

12. Battery Sw. .... OFF

13. Parking Brake .... CHECK

14. Cockpit Windows .... CLOSED

WARNING: 1. Do not turn on the propeller brake switch when the engine speed is above 3000 rpm.

2. Keep away from the engine exhaust pipe outlet for 5 min. after engine shut down because the residual fuel may be ignited.

3. Place the H.P. cock lever in Fuel OFF position positively. There is possibility of explosion at next starting if there is fuel leak in the engine after shut down.

4. When the H.P. cock lever is moved to OFF, cover the positions below OFF with a hand so that it can not be moved to the feather position inadvertently. If the H.P. cock lever is placed in the feather position, the propeller may be feathered by the remaining oil pressure.

4.9.8 Motoring Cycle Procedures

1. Blow Out (Dry Cycling)
   - (1) Propeller Pitch .... CHECK GROUND FINE PITCH
   - (2) Low Stop Lever .... GROUND
   - (3) H.P. Cock Lever .... FUEL OFF
   - (4) Fuel Booster Pump .... ON
   - (5) Fuel Pressure W/L .... OUT
   - (6) Relight Sw. .... OFF
   - (7) Engine Selector .... AS REQUIRED
   - (8) Starter Master Sw. .... BLOW OUT
   - (9) Propeller Stop .... CHECK
   - (10) Fire Guard .... CHECK
   - (11) Starter Button .... PUSH
   - (12) Starter Motor Ind. Light ..... CHECK ON
   - (13) Starter Master Sw. .... SAFE (After 30 sec. of Motoring)
   - (14) Starter Button & Ind. Light .. CHECK OUT
   - (15) Fuel Booster Pump .... OFF

CAUTION: 1. DO NOT EXCEED THE MAXIMUM ALLOWABLE DURATION OF 30 SEC. WHEN THE STARTER MOTOR IS USED FOR MOTORING CYCLE.

2. TAKE 15 MIN. REST AT LEAST AFTER 6 SUCCESSIVE STARTING CYCLES OR MOTORING CYCLES IN ORDER TO COOL THE STARTER MOTOR.

2. Blow Out (Wet Cycling)

(1) Take the same procedures as those for the "Dry Cycling." However, keep the H.P. cock lever in the high stop withdrawal for 20 sec. during the 30 sec. motoring cycle.

(2) Conduct the dry cycling after the wet cycling.

4.9.9 Fire during Start

1. Starter Master Sw. .... SAFE

2. H.P. Cock Lever .... FEATHER

3. Feathering Button .... PUSH

4. Emerg. Fuel Shut-off Handle ...... PULL

5. Fire-Extinguisher .... 1st SHOT
   (2nd Shot If Necessary)

NOTE: 1. If the other engine is running, feather it to facilitate fire fighting on the ground.

2. When an engine is feathered, pull the emergency fuel shut off handle as quickly as possible.

6. Propeller Feather Angle .... CHECK

7. Throttle Lever .... MIN.

8. Booster Pump .... OFF

4.9.10 Exhaust Pipe Fire

1. Throttle Lever .... MIN.

2. H.P. Cock Lever .... FUEL OFF

3. Ignition C/B .... OFF

4. Engine Selector Sw. .... AS REQUIRED

5. Starter Master Sw. .... BLOW-OUT

6. Starter Push Button .... PUSH

WARNING: After making sure that the propeller has completely stopped, push the starter push button.

7. Starter Master Sw. .... SAFE
   (After 30 Sec. of Motoring)

4.9.11 Landing Gear Well Fire

1. H.P. Cock Lever .... FEATHER

2. Feathering Button .... PUSH
   (Complete Feather .... CHECK)

3. Emerg. Fuel Shut Off Handle ...... PULL

4. Fire Extinguisher Sw. .... 1st SHOT

5. Throttle Lever .... MIN.

6. Fuel Booster Pump .... OFF
   (2nd Shot if Necessary)

Chapter 5 FUEL AND WATER/METHANOL SYSTEM

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Chapter 5 FUEL AND WATER/METHANOL SYSTEM

5.1 General Description

5.1.1 Fuel System

(1) Fuel Tank

Fuel tanks are located inside starboard and port wings. Main fuel tanks are integral and installed outboard the engine nacelle. There is a provision for bag tank installation as auxiliary tanks to meet customer's requirement. Auxiliary tanks are installed between the front and the rear spars of starboard and port wings inboard the engine nacelle.

(2) Fuel Refueling

Fuel refueling is implemented by pressure feed system through the filler located on the lower surface of the wing. Alternatively, gravity refueling is accomplished through the over wing filler.

(3) Fuel Specifications

Fuel used in this aircraft shall conform to the following specifications.

Group A

ASTM D 1655-59T Type A or Type A-1
British D. Eng. R.D. 2482, 2494 or 2498
Canadian 3-GP-23e Type 1
I.A.T.A. Kerosine Type Fuel
MIL-J-5624F Grade JP-5

Group B

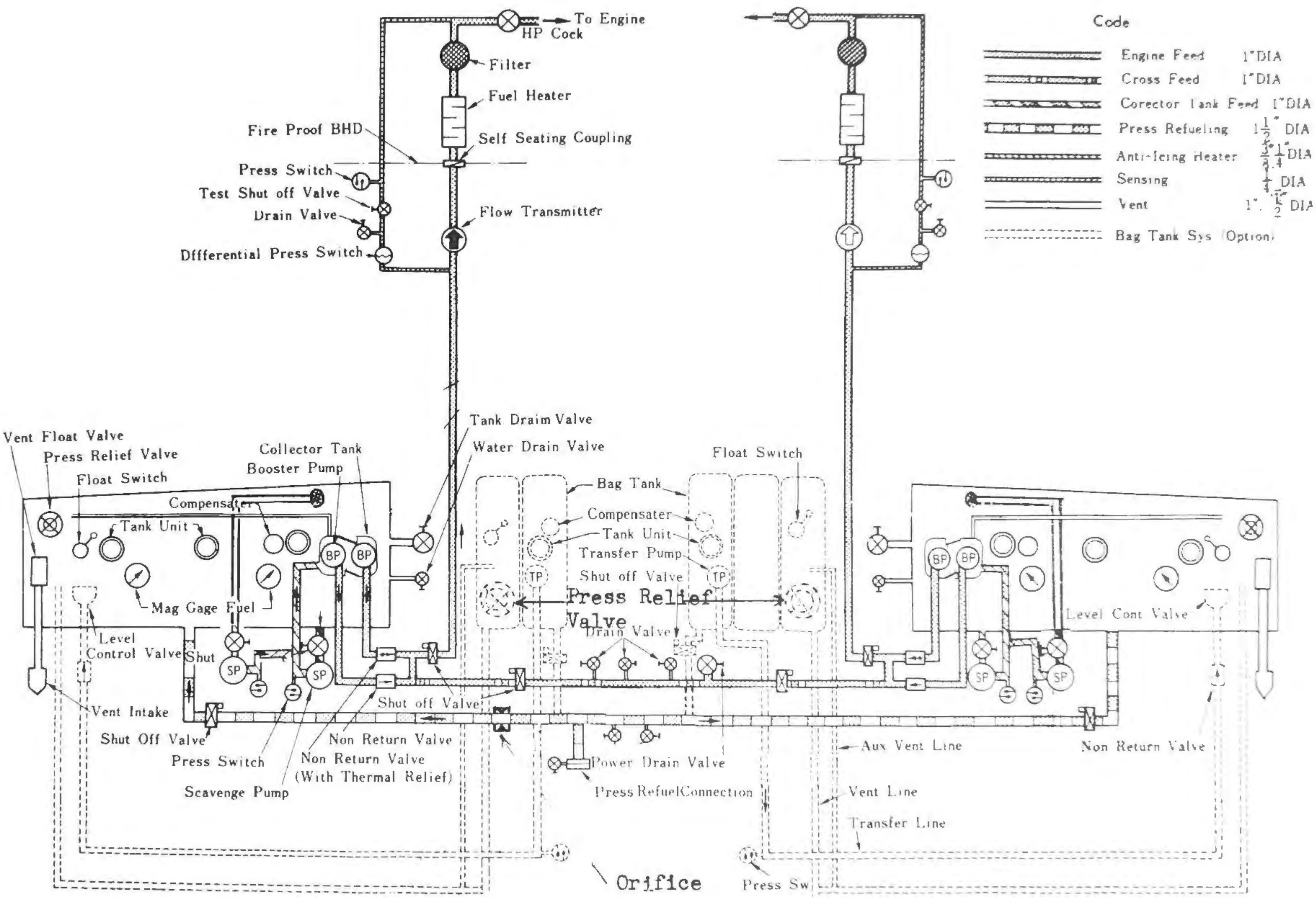
British D. Eng. R.D. 2486
Canadian 3-GP-22d Type 2
ASTM D 1655-59T Type B
I.A.T.A. Wide-cut Type Fuel
MIL-J-5624F Grade JP-4

(4) Fuel Feed

Fuel is supplied to engines from main tanks under pressure by means of the submerged type booster pump. The pressure supply is intended to prevent vapor lock in the system.

Fuel in auxiliary bag tanks is transferred to main tanks by means of the fuel transfer pump.

Cross feed system is incorporated between starboard and port main tanks. The collector tank which forms an isolate chamber, and a scavenge system are installed in the main tanks to minimize the unusable fuel quantity in the tanks.



Fuel System Piping Schematic Diagram
Figure 5-1

(5) Fuel De-icing

The fuel de-icing system is installed in the fuel feed line to prevent fuel from icing.

(6) Fuel Quantity Indicating System

The fuel quantity indicating system is provided with two kinds of fuel gauges; two direct reading fuel quantity indicator mounted on the lower surface of the wing and an electrical capacity type fuel quantity indicator mounted on the pilot instrument panel.

(7) Cap Identification Marking

The following colors are painted on the filler caps for identification purpose:

W/M Filler Cap ..... White
Fuel Filler Cap ..... Red
Oil Filler Cap ..... Yellow

(8) Valves and pipes which can not be identified easily are provided with placards and marking tapes, respectively.

5.2 Fuel Tank - Integral

5.2.1 General Description of Integral Fuel Tank

The integral fuel tank is provided, one in each of the right- and left-hand wings, located between W. STA 4000 and W. STA 9600, being formed by bulkheads and front and rear spars with a vent. On the lower surface of the wing are installed four manholes for inspection of tank interior and one booster pump attaching mount.

The manhole cover is sealed with rubber gasket and secured with screws. On the upper surface of the wing is located one filler cap for alternative fuel refueling means (gravitation refueling); no other inspection holes are provided.

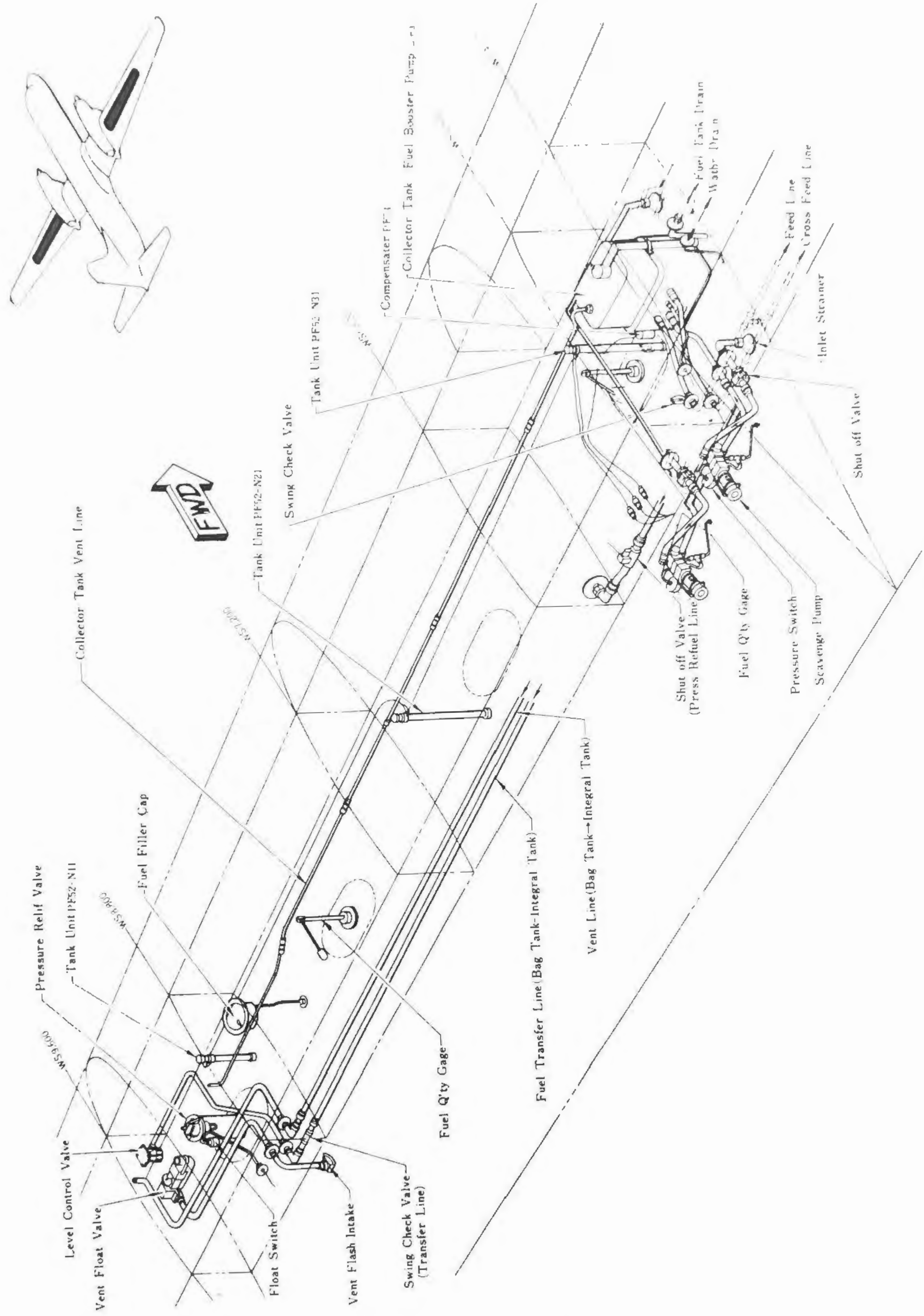
Inside the tank the components of each sub-system are installed. Of the components, most of those which are connected to pipes and electric wires outside the tank have their connections on the face of the rear spar.

Components installed inside the tank are, except the booster pump, checked or replaced through the manholes. Before accomplishing checks and replacement of components, the fuel shall be defueled entirely.

The fuel tanks are numbered as follows:

L.H.	Integral	Tank	No. 1	(Main Tank)
L.H.	Bag	Tank	No. 2	(Aux Tank-Option)
R.H.	Bag	Tank	No. 3	(Aux Tank-Option)
R.H.	Integral	Tank	No. 4	(Main Tank)

In case the optional tank is not provided, its number is skipped.



All Equipments in Integral Tank

Figure 5–2

5.2.2 Tank Specifications

Total Capacity	2,644ℓ (about 700 U.S. gallons)
Pressure Refueling Amount	2,495ℓ (about 659 U.S. gallons)
Gravity Refueling Amount	2,520ℓ (about 666 U.S. gallons)
Unusable Fuel Amount	14ℓ (about 3 U.S. gallons)
Expansion Space	124ℓ (equivalent to 4.7% of the total capacity)
Proof pressure of tank	3.5 psi.

Reserved

5.2.3 Construction of Integral Tank (Fig. 5-3)

The inner walls of the integral fuel tank are made up of upper and lower wing panels, front and rear spars, and bulkheads at the wing stations 4000 and 9600. Their inner surfaces are sealed with sealing compound and further top-coated all over.

Inside the tank are installed bulkheads to prevent fuel from centering toward the wing tip when the aircraft is banked to the left or right, and trusses for stiffening the wing structure.

The bulkheads are located at W STA 4500, 5600, 7200 and 8800. Bulkheads except one at W STA 4500 are riveted.

The bulkhead at W STA 4500 is attached with screws and provided with three swing check valves. Between the bulkhead and the stringer a clearance is provided to allow fuel to flow.

Trusses are located at W STA 5100, 6100, 6700, 7700 and 8300. Truss members are detachable to facilitate inspection of the interior.

5.2.4 Tank Sealing - Integral (See Fig. 5-3)

The tank is sealed by the combined use of the following methods and sealants.

(1) Face Sealing (Faying Surface Sealing)

It is a method used on the faying surfaces between the structural components such as the skins, spars, rib and the like, and on the faying surfaces of the reinforcements and longerons mounted directly on the structural components.

Compound to be used: PR-1431 Types I, II and III

(2) Corner Sealing

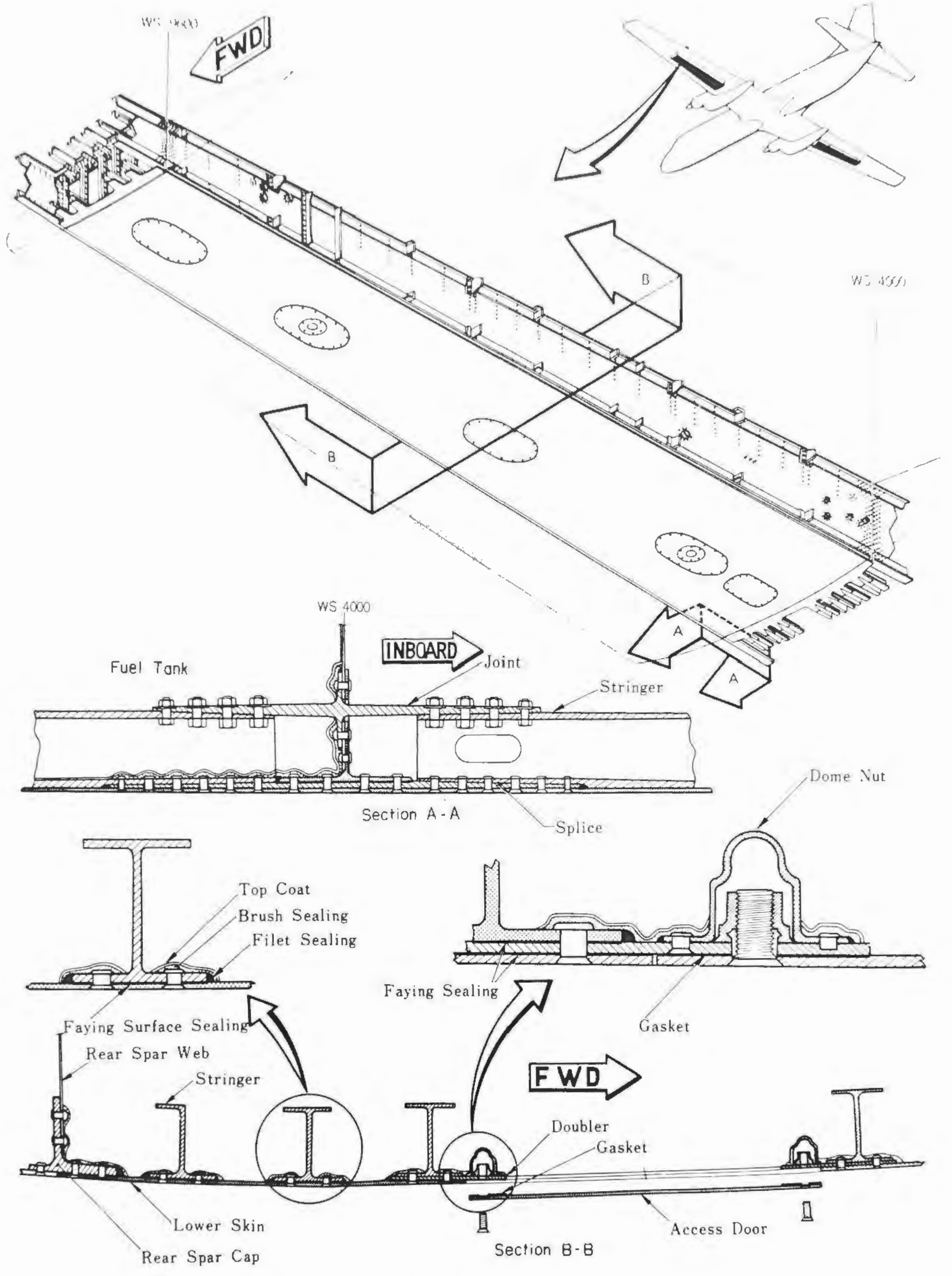
It is a method used for the corners where the structural components are joined together with corner fittings, and is also used for the corners, grooves and where there are gaps.

Compound to be used: PR-1422 Class B-2

(3) Fillet Sealing

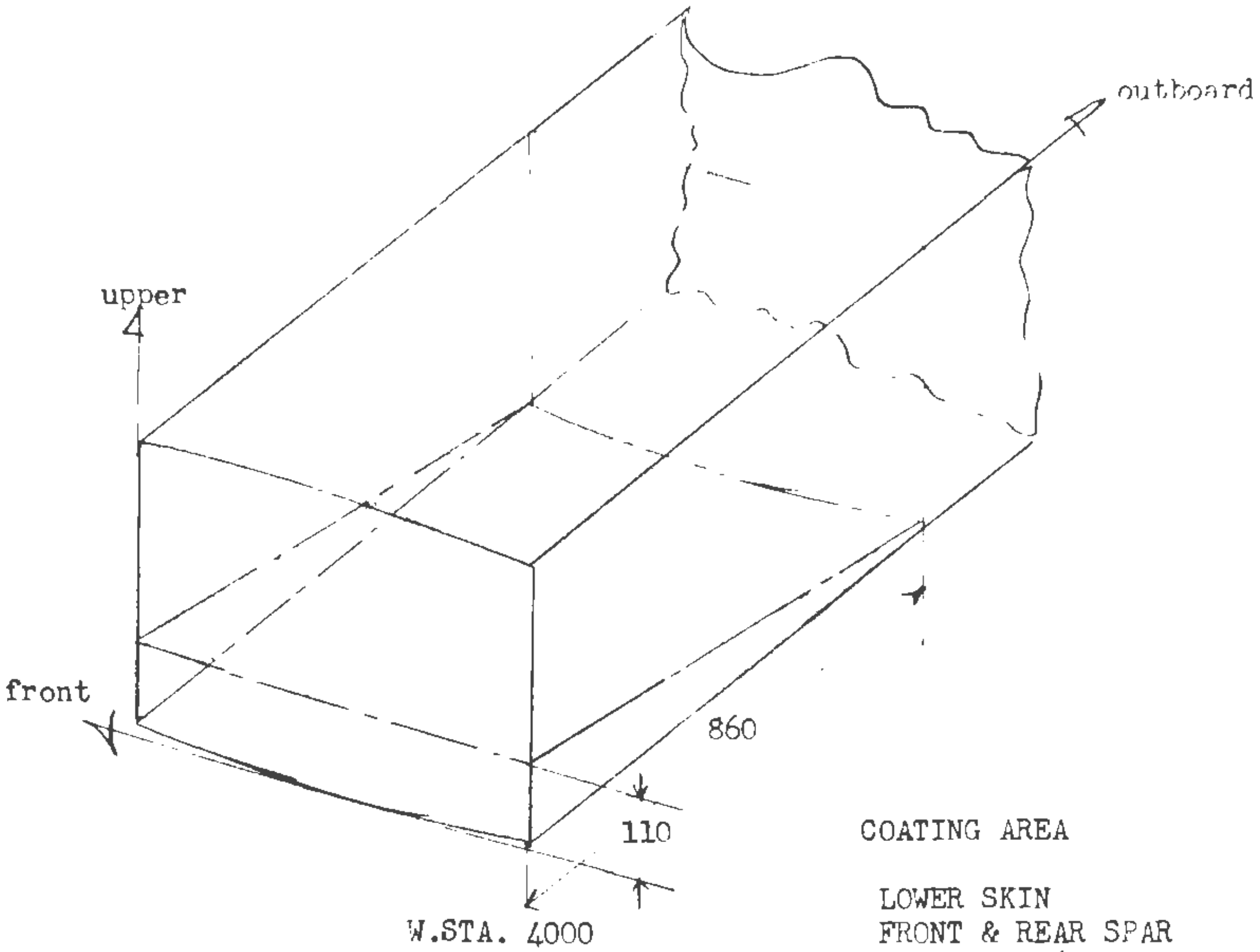
Fillet sealing is employed where the skins, reinforcements and longerons are joined together and for the joints and gaps which are likely to cause leakage all around such points.

Compound to be used: PR-1422 Class B-2



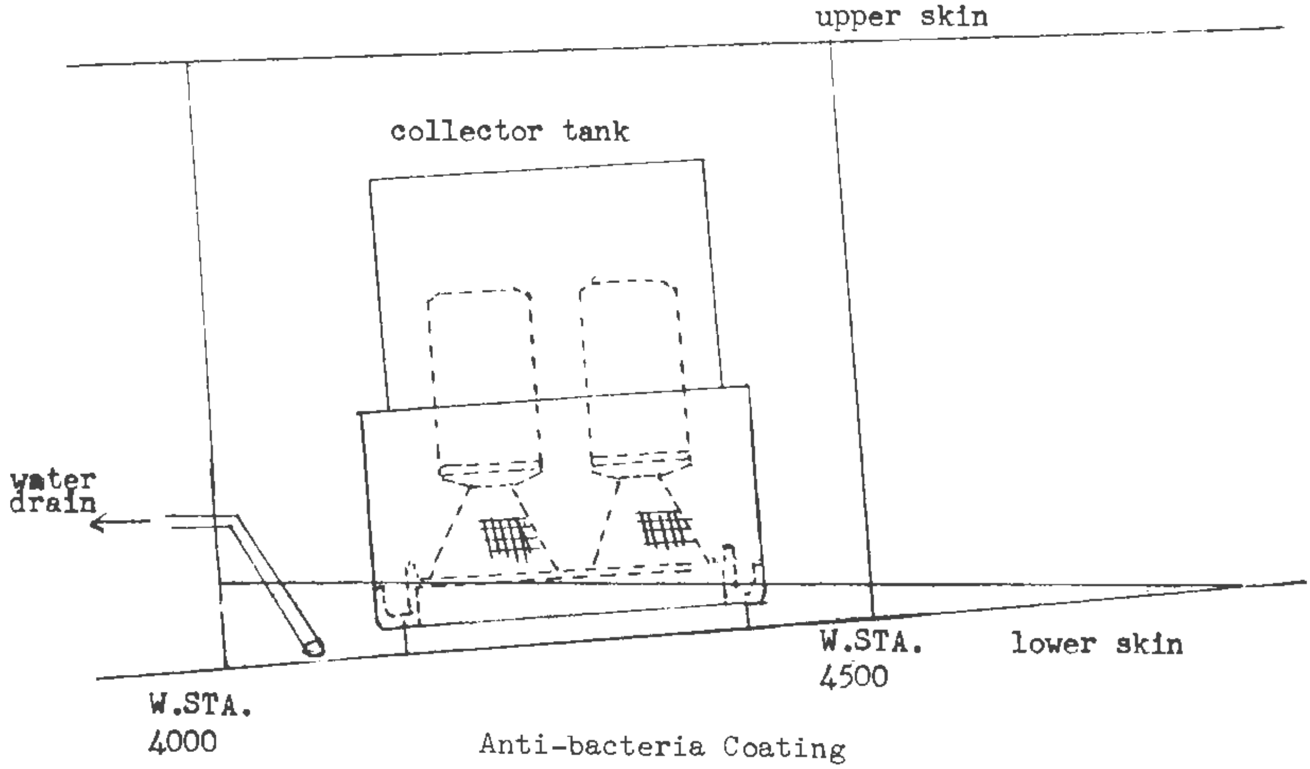
Integral Tank Structure General

Figure 5–3



COATING AREA

LOWER SKIN
FRONT & REAR SPAR
W.STA.4000(only outside)
& W.STA. 4500 BULKHEADS
COLLECTOR TANK



Anti-bacteria Coating

Figure 5-3A

(4) Brush Sealing

Brush sealing is accomplished by applying sealant on the bolt heads, rivet heads and the faying surfaces of small sheets with a brush.

Compound to be used: PR-1422 Class A-2

(5) Top Coating

Top coating is employed to finish tank sealing with the final protective coating after having applied sealing method (1) through (4) described above.

Compound to be used: PR-1005L Types I and II

(6) Anti-bacteria Coating (Fig. 5-3A)

Anti-bacteria coating is provided on the top coating (PR-1005L) of a part of the integral tank. For its extent, see Fig. 5-3A.

Coating material to be used: DV-1180

5.2.5 Components Installed in the Tank - Integral (See Fig. 5-2)

Following components are installed in each wing.

Installed Component	Quantity
Fuel Booster Pump	2
Collector Tank	1
Scavenge Pump Inlet Screen	2
Direct Reading Type Fuel Quantity Sight Gage	2
Tank Unit	3
Compensator	1
Over Wing Filler	1
Pressure Relief Valve	1
Vent Float Valve	1
Float Switch	1
Tank Drain Valve	2

(1) Construction and Operation of Filler and Vent of the Tank

A. Over Wing Filler (See Fig. 5-4)

This is a manually operated, Lock and Unlock marked, airtight cap made by Roylyn, U.S.A.

The neck which forms principal part of the cap is riveted to the cylindrical filler pan. The pan is riveted to the upper wing surface. A cover plate provided with a latch is attached to the pan in even level with the wing surface.

The bottom of the filler pan is provided with a pipe fitting for letting overflow fuel during refueling drop below the lower wing surface.

The cap installed on the neck is guaranteed to be air tight against 25 psi from inside the tank and 3 psi from outside the tank.

The cap can be locked or unlocked by rotating it approximately 40°. The marking in the round opening in the surface of the cap consists of the following:

Yellow in UNLOCK position
Red in between
Green in LOCKED position

B. Pressure Relief Valve (See Fig. 5-5)

This valve is provided with a simple mushroom shaped spring. When the internal pressure is applied to the top of the valve, the valve is brought down against the spring force, producing a gap between the valve and the valve seat, through which fuel can flow through the large cylindrical mounting pipe and is directly discharged to the ground below the lower wing surface.

The cracking pressure of the valve is 1.5 psi. It requires a pressure gradient of 2.3 psi at a flow rate of 200 U.S. gal/min.

C. Vent Float Valve (See Fig. 5-6)

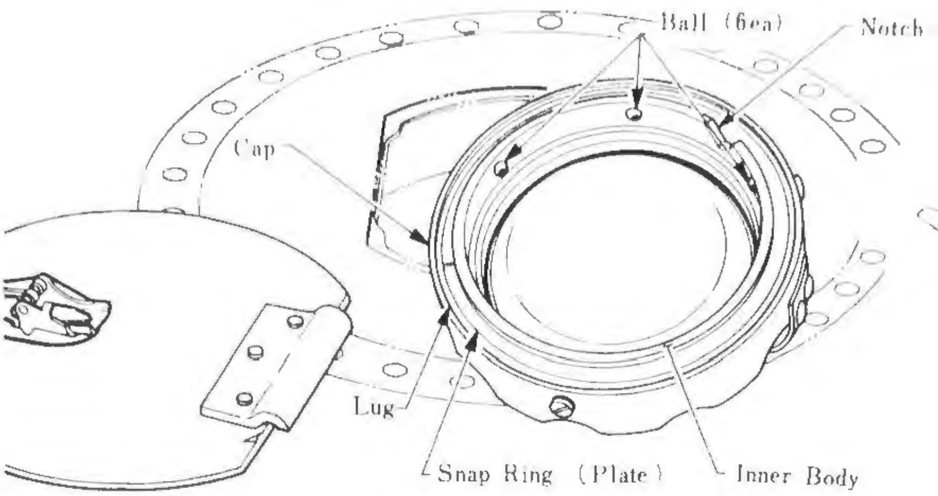
This valve is provided to accomplish the ventilation of the tank, prevention of fuel overflow, relief of tank internal pressure and alleviation of negative pressure in the tank.

Opening or closing of the flapper accomplish the above-mentioned function.

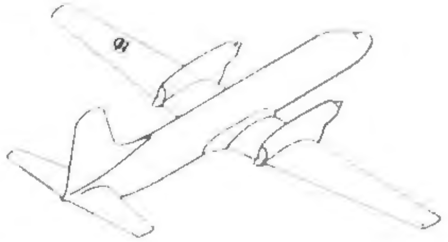
Ventilation: When the fuel level in the tank does not reach the float, the flapper is open to vent the tank.

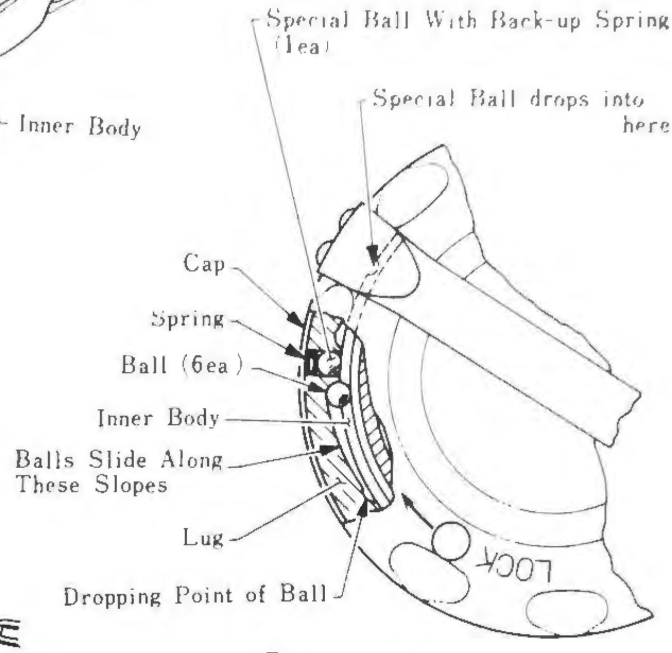
Prevention of Fuel Overflow: When fuel in the tank rises above the level where the float kept afloat, the flapper is closed accordingly.

Alleviation of Negative Pressure: If fuel is consumed under the condition of closed flapper valve, the negative pressure inside the tank will be developed. At this point, the spring on the flapper is collapsed because the flapper is forced up by the external air pressure which passes through the suction port.

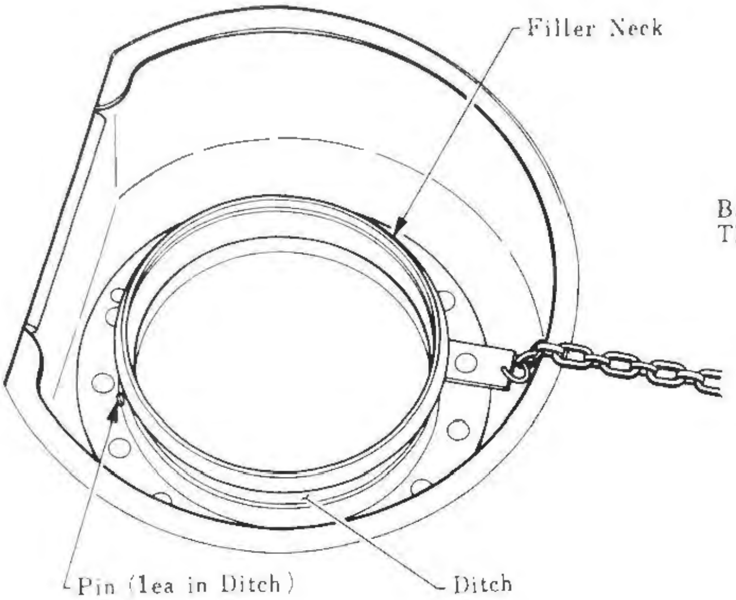


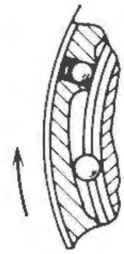
Back Side of Filler Cap



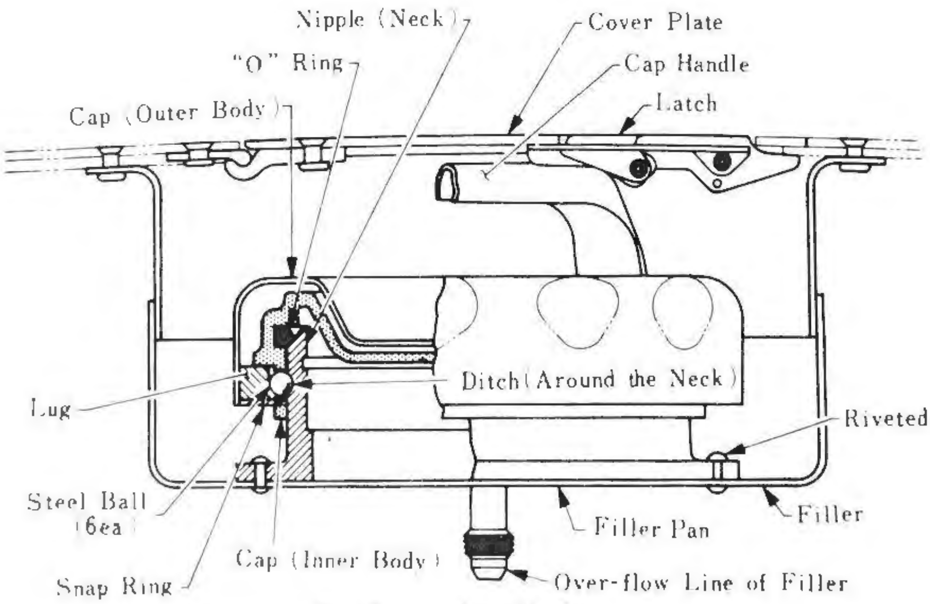


(1) Unlock Position

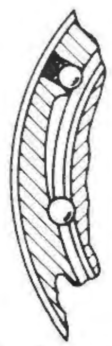




(2) Unlock → Lock



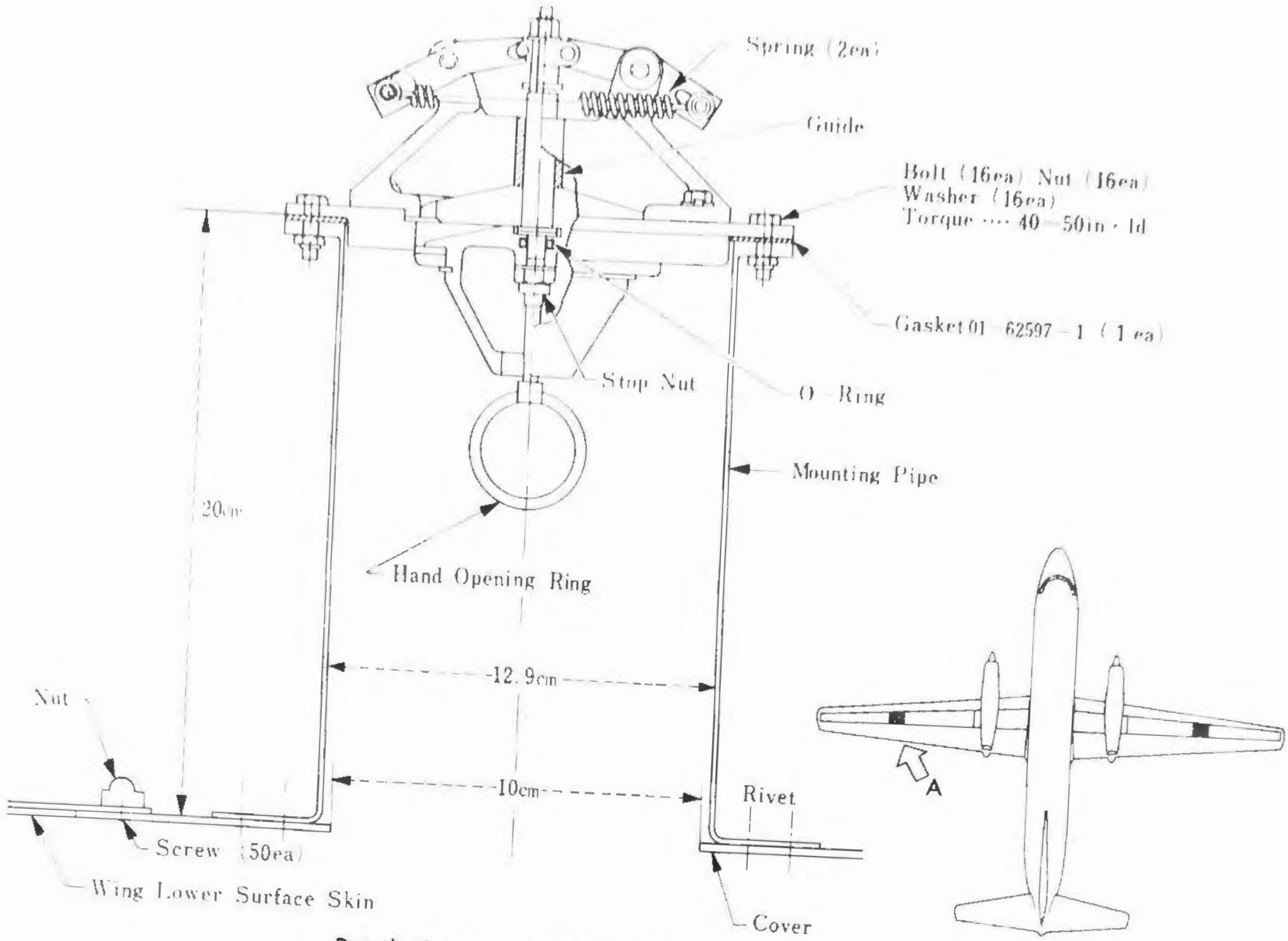
Cop Secured to Neck



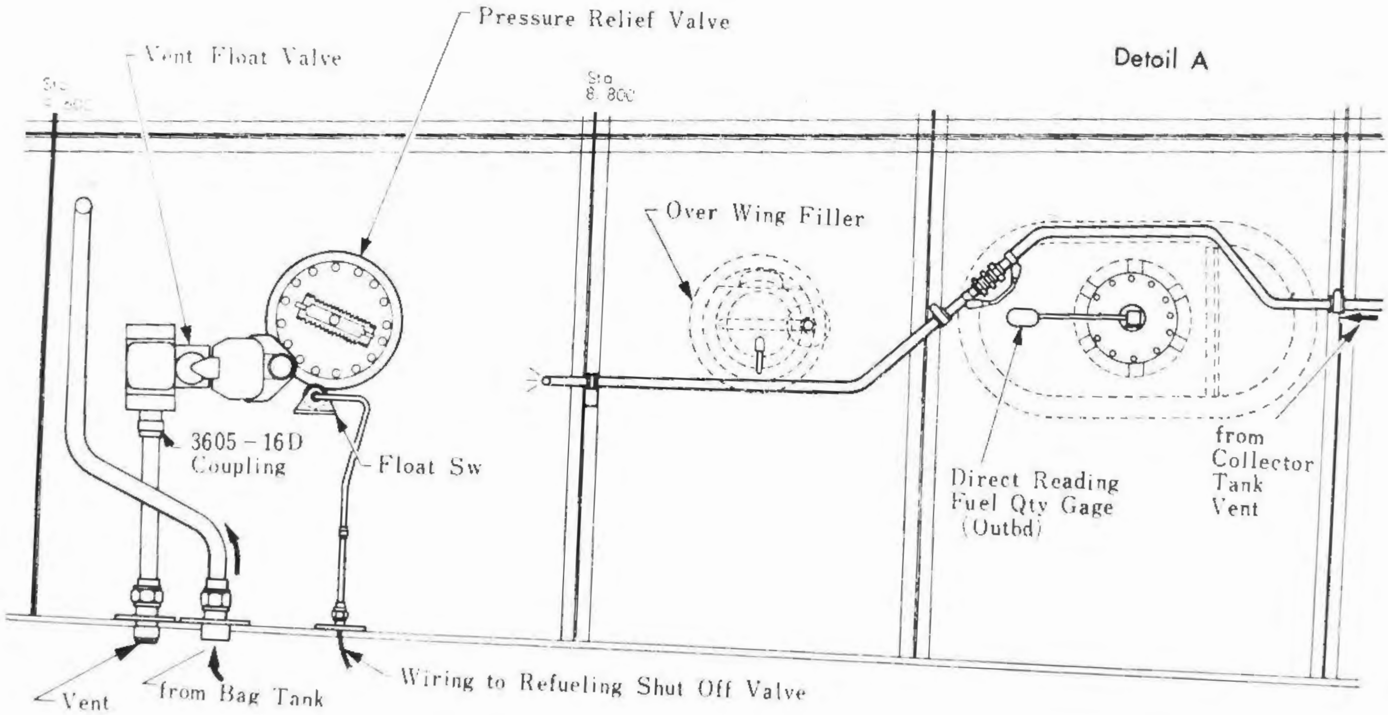
(3) Lock Position

Overwing Fuel Filler Cap

Figure 5-4



Detail of Pressure Relief Valve



Fuel Tank Pressure Relief Valve
Figure 5–5

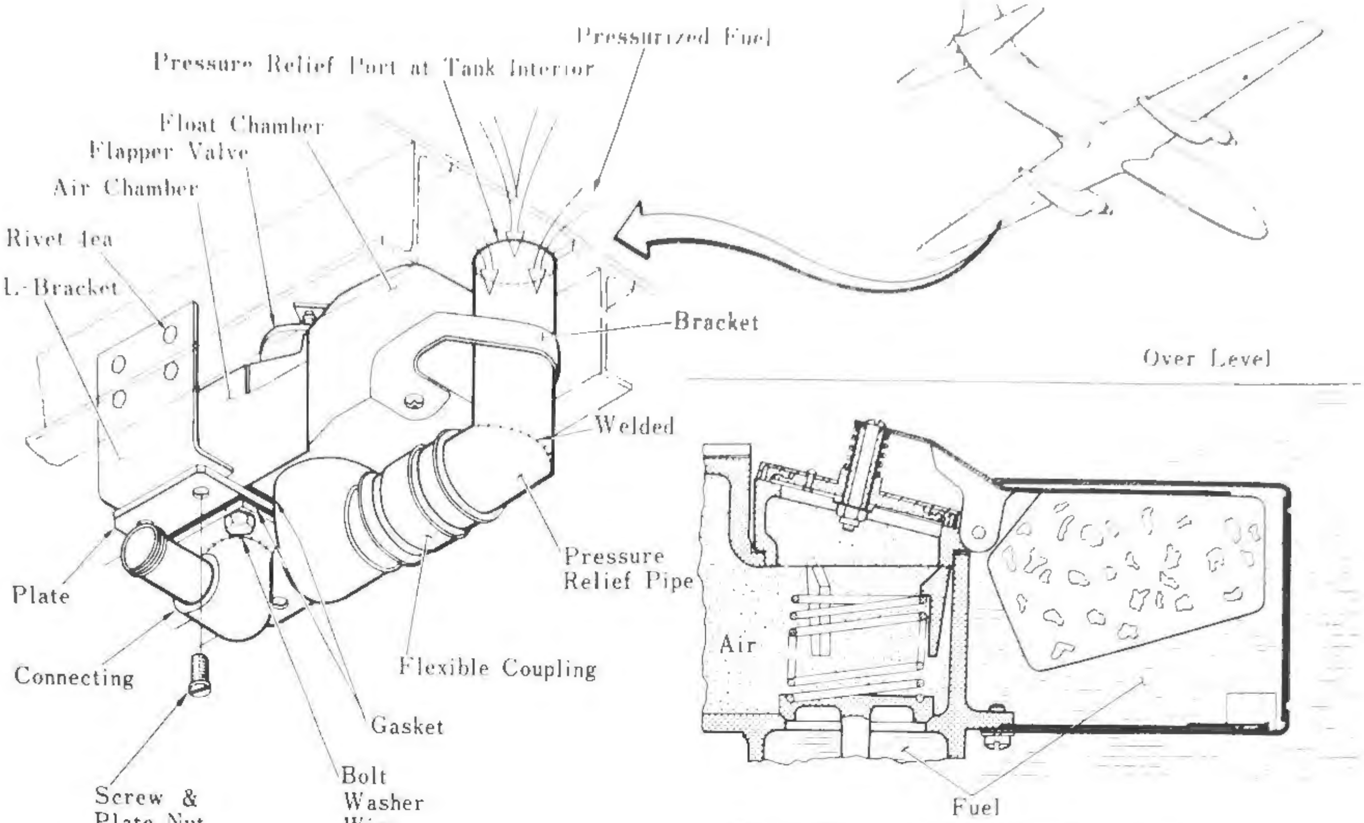
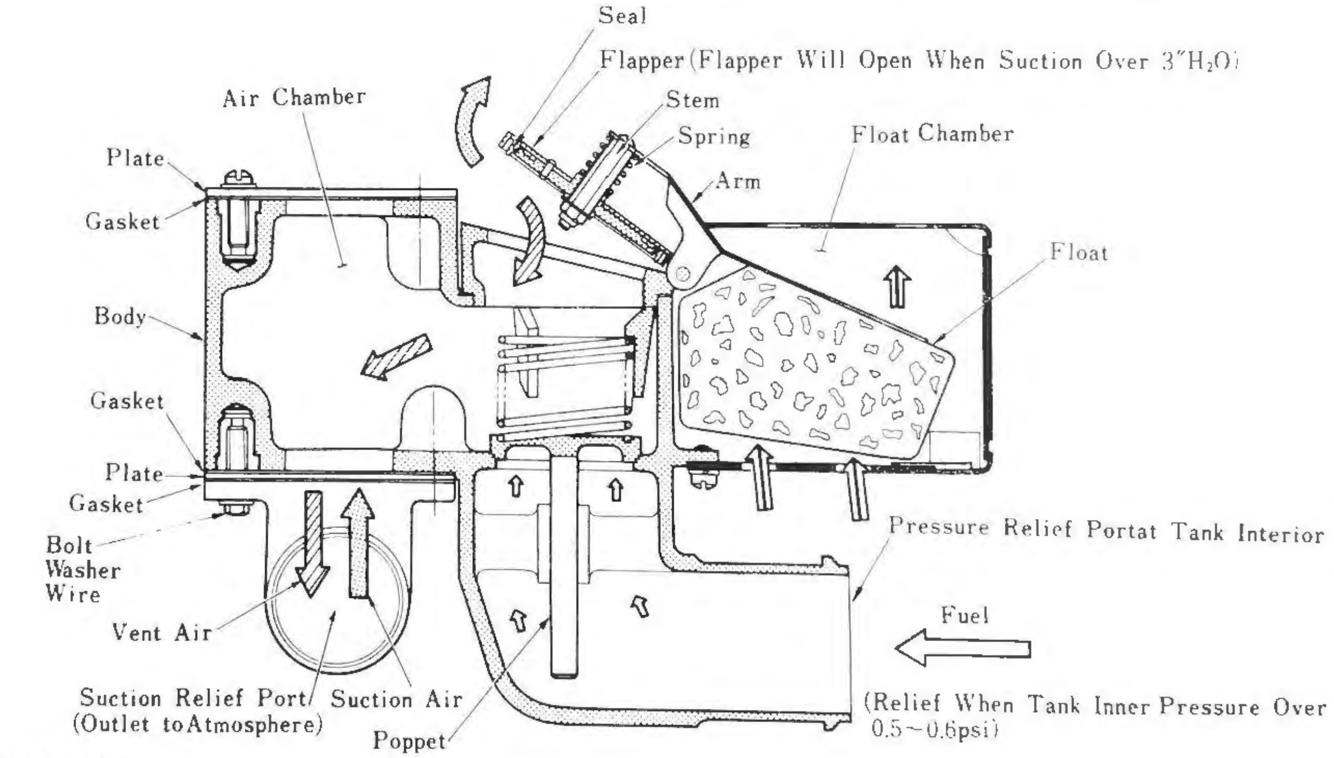


Figure Shows the Condition of over-flow prevention. Vent function is stopping.

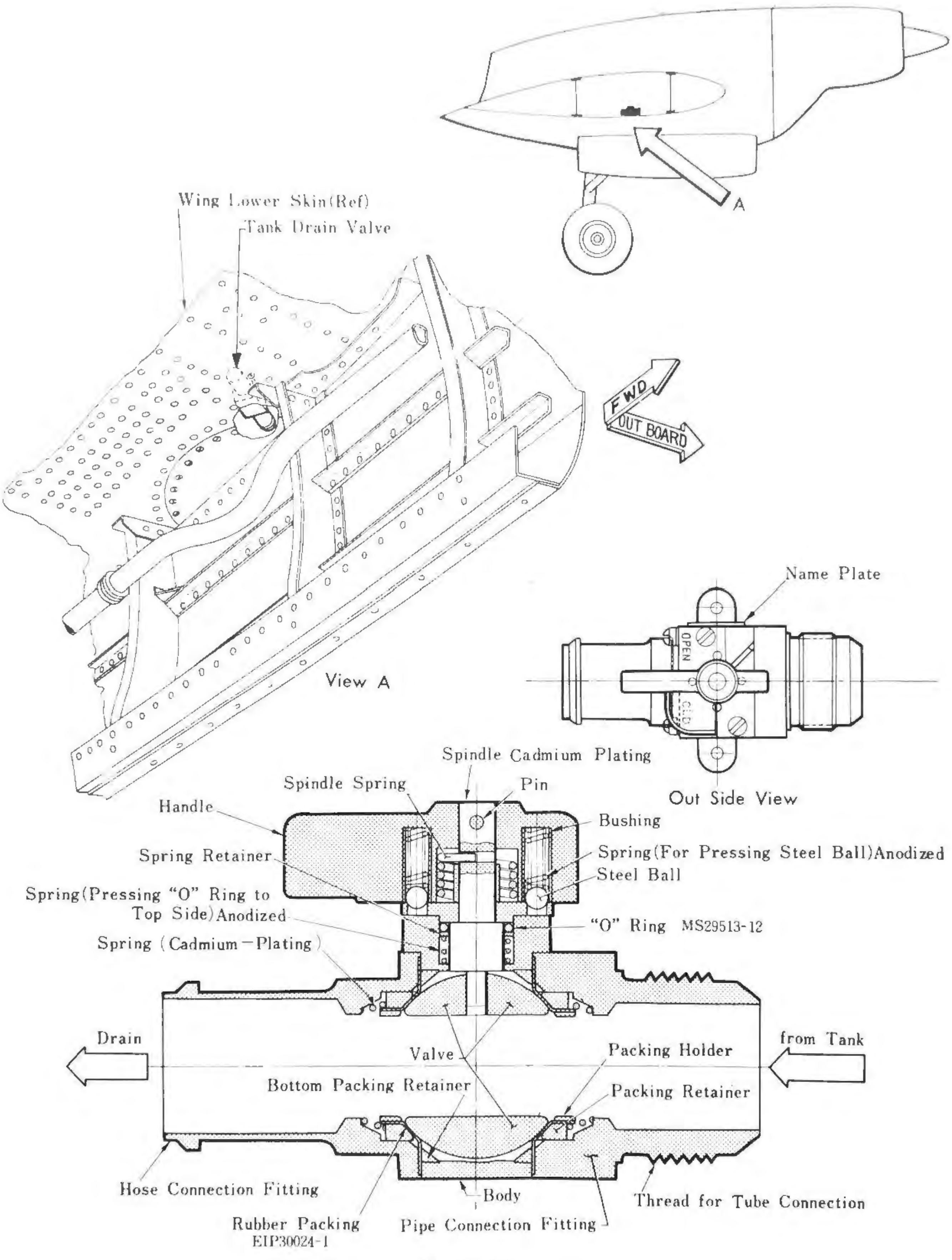


REMARK :

- Tank internal air & Fuelgas mixture (escaping to Outside of Tank)
- Outside Fresh Air (going into Tank interior)
- Pressurized Fuel (relief to Outside passing through Relief Valve via Air Chamber)
- Tank Fuel (only when fuel level over)

Fuel Vent Float Valve

Figure 5–6



Fuel Tank Drain Valve
Figure 5–7

Relief of Internal Pressure of the Tank: As the internal pressure of the tank grows higher, the fuel or gas climbs up from below and opens the poppet of the pressure relief port which is normally kept in the closed position by the spring to relieve the internal pressure (opening pressure is 0.5 psi).

D. Drain Valve (See Fig. 5-7)

It is a manually-operated, 1 inch size, two way valve. The valve has a flow path which is opened or closed by the 90° switchover of the handle.

5.3 Fuel Refueling System

5.3.1 Gravity Refueling

Filler cap is provided on the upper surface of the wing at each tank location as supplementary refueling means.

Gravity Refueling Amount is as follows:

No. 1 Tank 2,520ℓ (about 666 U.S. gal.)
No. 4 Tank 2,520ℓ (about 666 U.S. gal.)

NOTE: Regarding construction and operation of Filler Cap, see "Chapter 5.2 Fuel Tank."

5.3.2 Pressure Refueling (See Fig. 5-8)

The purpose of the pressure refueling is to shorten the refueling time.

Refueling ports are located near W STA 0 of L.H. side. The refueling piping is routed on the back side of the wing rear spar, entering the tank at W STA 5500. At the tank inlet, a screen assembly is installed to disperse the incoming fuel.

Pressure Refueling Amount is as follows:

No. 1 Tank 2,495ℓ (about 659 U.S. Gal.) 50 psi 200 U.S. Gal./min.
No. 2 Tank 2,495ℓ (about 659 U.S. Gal.) 50 psi 200 U.S. Gal./min.

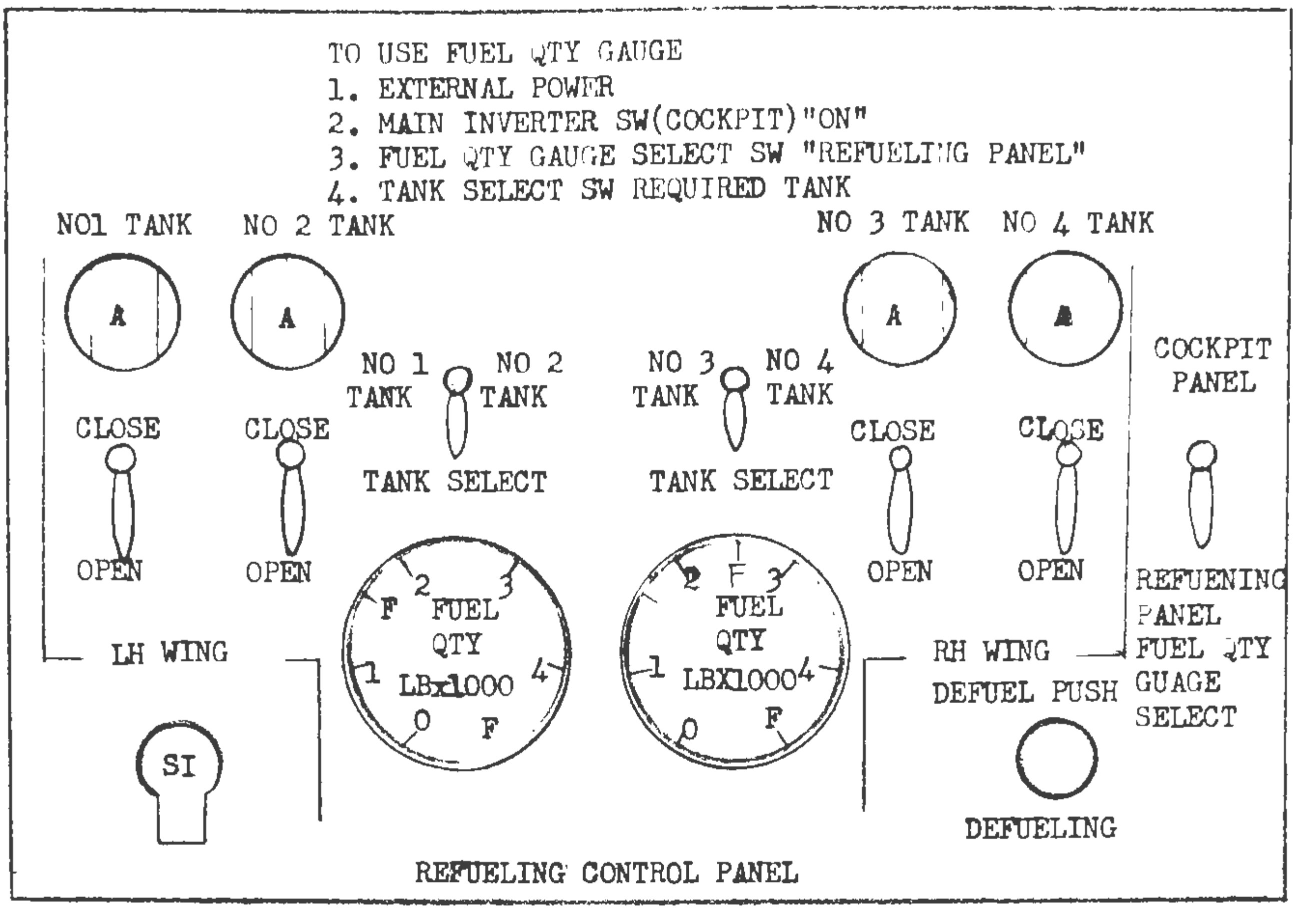
5.3.3 Construction of Pressure Refueling System (Fig. 5-8A, 5-8B)

Refueling system components and locations are as follows.

(1)	Control panel	W STA 0
(2)	Shut-off valve	In refueling line
(3)	Float switch	Inside tank
(4)	Circuit Breaker	Outboard side of nacelle (Only Left Nacelle)

Deleted

Figure 5-8


TO USE FUEL QTY GAUGE
1. EXTERNAL POWER
2. MAIN INVERTER SW(COCKPIT)"ON"
3. FUEL QTY GAUGE SELECT SW "REFUELING PANEL"
4. TANK SELECT SW REQUIRED TANK
NO1 TANK
NO 2 TANK
NO 3 TANK
NO 4 TANK
NO 1 TANK
NO 2 TANK
TANK SELECT
NO 3 TANK
NO 4 TANK
TANK SELECT
COCKPIT PANEL
CLOSE
OPEN
FUEL QTY LBx1000
FUEL QTY LBX1000
LH WING
RH WING
DEFUEL PUSH
REFUENING PANEL FUEL QTY GUAGE SELECT
SI
DEFUELING
REFUELING CONTROL PANEL

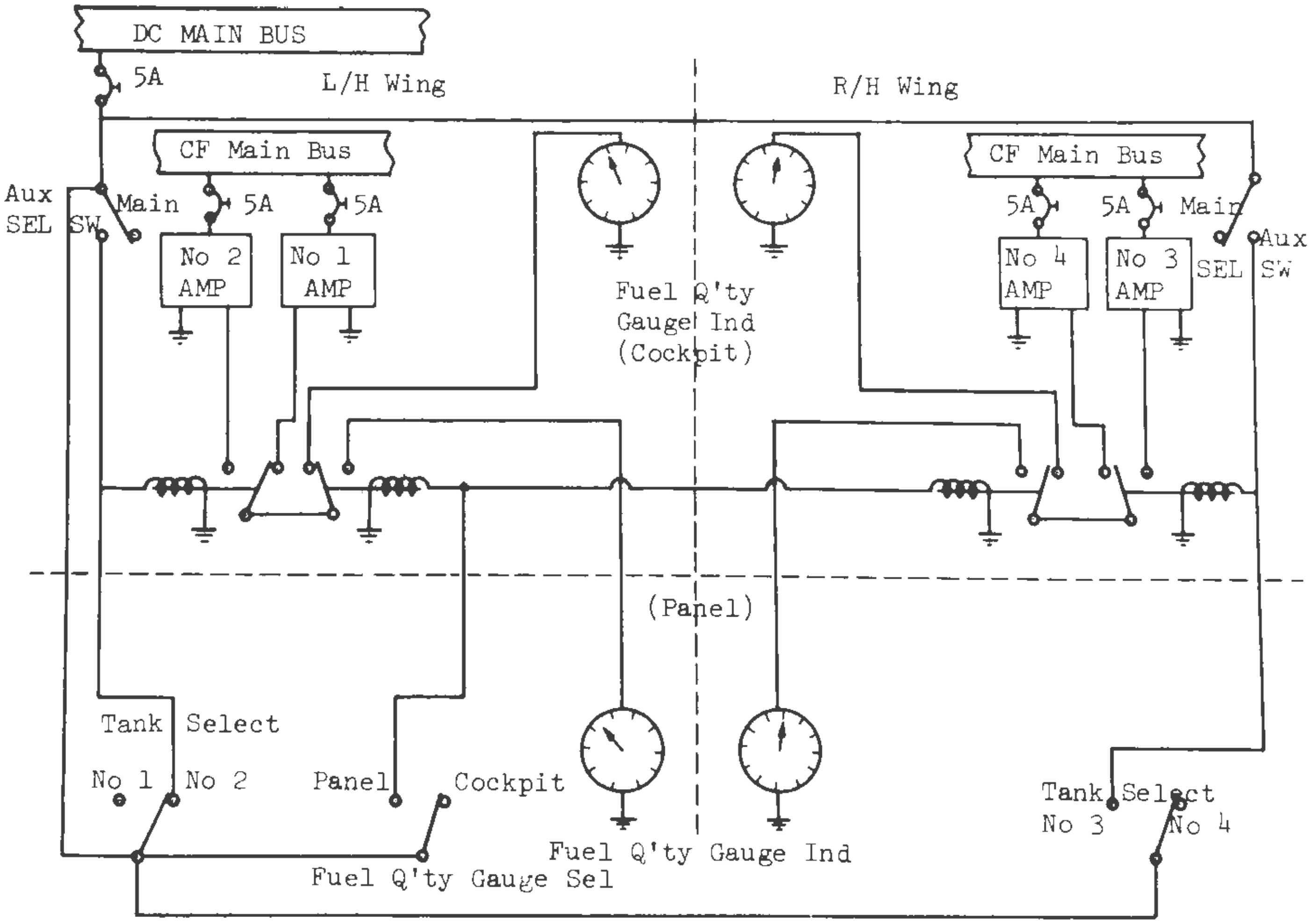
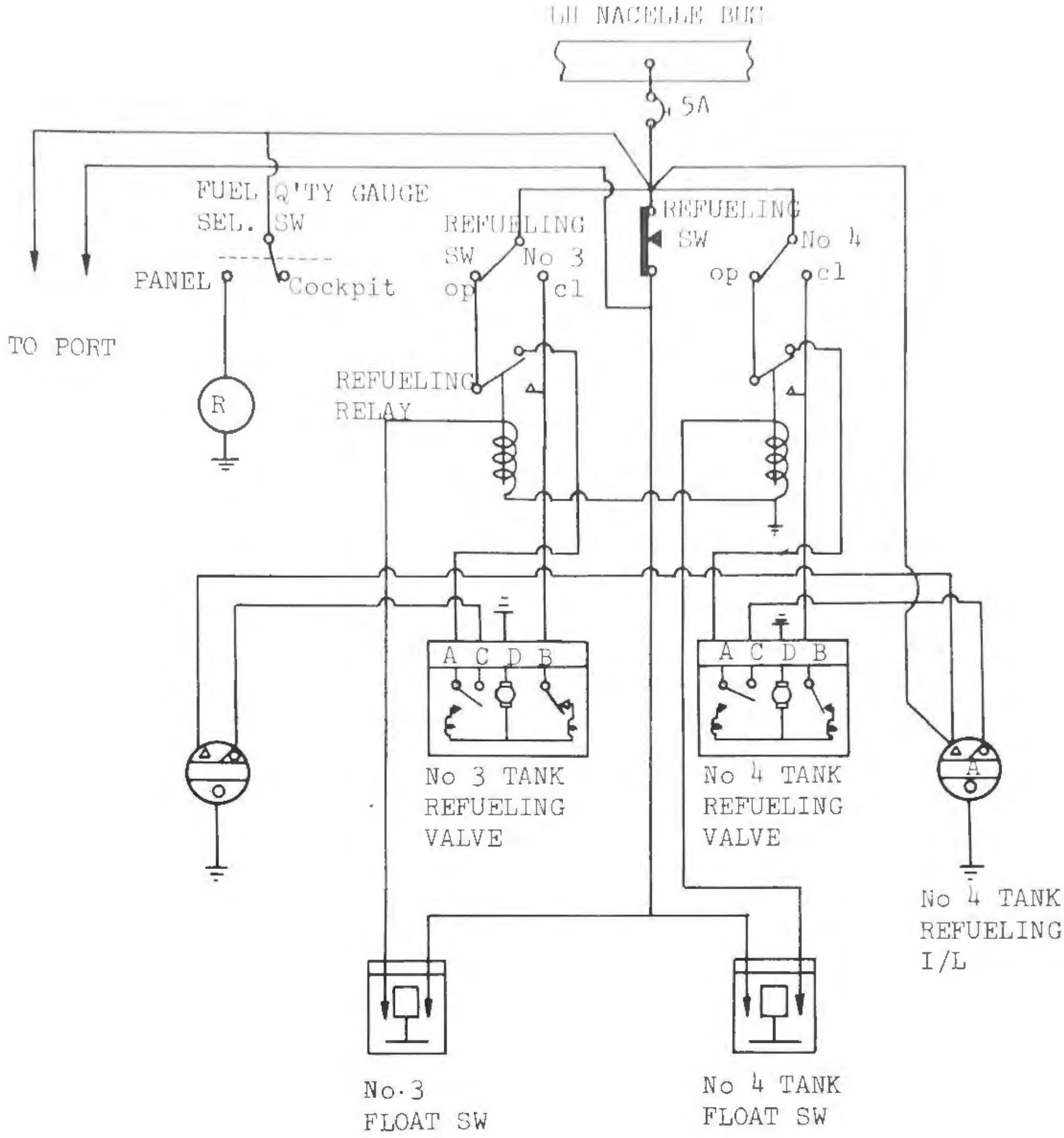

DC MAIN BUS
5A
L/H Wing
R/H Wing
CF Main Bus
Aux SEL SW
Main
No 2 AMP
No 1 AMP
No 4 AMP
No 3 AMP
Fuel Q'ty Gauge Ind (Cockpit)
(Panel)
Tank Select
No 1
No 2
Panel
Cockpit
Fuel Q'ty Gauge Sel
Fuel Q'ty Gauge Ind
Tank Select
No 3
No 4

Figure 5-8A



Pressure Refueling Electrical Schematic

Figure 5-8B

(5) Adapter Control panel

(6) Drain valve Adapter

On the refueling control panel are arranged four switches for operating the shut-off valve, four amber lights for indicating the valve position (close or open), and one interphone jack. In addition, the panel is provided with the fuel quantity indicator, its changeover switch and the tank selector switch.

Adapter in fuel refueling port is check valve type adapter and prevents fuel from flowing in reverse direction. Connect the refueling nozzle to the adapter and turn the control switch "ON," then the refueling shut-off valve on the refueling line opens, and simultaneously the indicating light comes on.

When the fuel flows into the tank to raise the fuel level to the prescribed one, the float switch closes the contact point to close the shut-off valve automatically.

Thus, refueling is accomplished and the refueling indicating light on the control panel goes out. When the amount of fuel in tanks is below the prescribed level, the control switch shall be turned to close the refueling shut-off valve. The interphone jack is used to contact the crew in the cockpit while refueling. The fuel quantity indication is shown either on the cockpit side or the panel side indicator by means of the changeover switch. The fuel quantity for each tank can be indicated by the tank select switch.

NOTE: As to the interphone circuit, see Chapter 10 ELECTRONIC SYSTEM.

The pressure relief valve is provided on the lower surface of the wing for the protection of the tank from excessive internal pressure be relieving it through the valve. In case when refueling can not be stopped due to defective float switch, the pressure relief valve opens. Opening pressure is 1.75 to 1.5 psi.

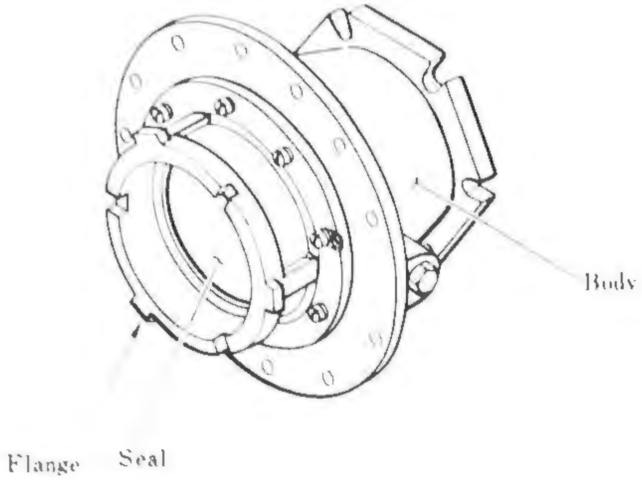
As the refueling control system power is supplied from the battery bus, the use of a control switch in the cockpit is not necessary.

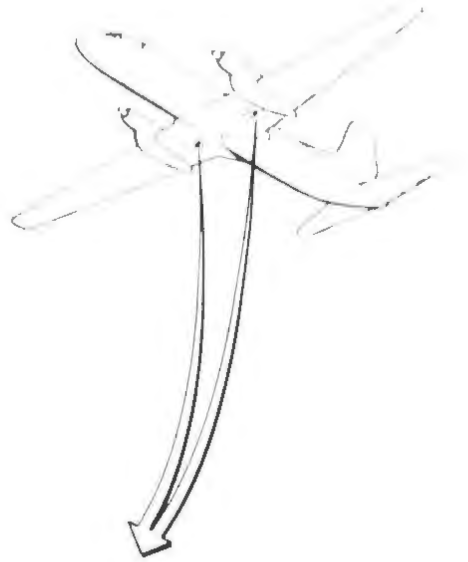
A. Adapter (See Fig. 5-9)

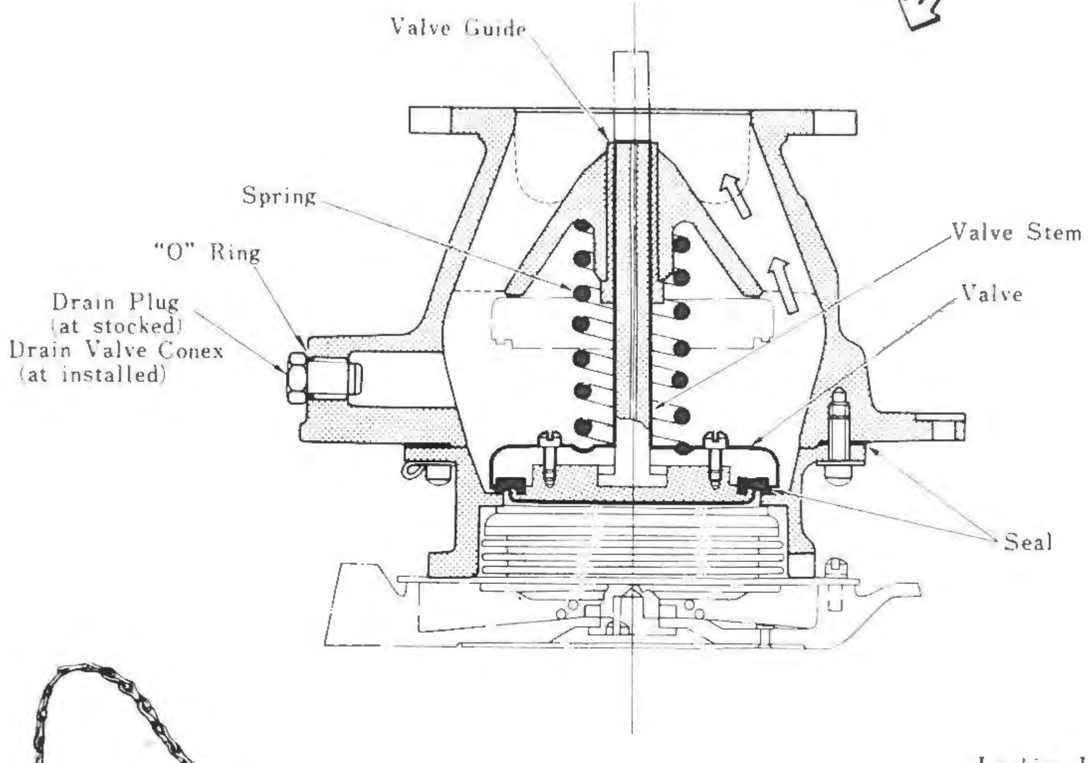
It is an aircraft coupling which is placed automatically in open position when the refueling nozzle is connected. As a cap is mounted on it, the adapter becomes a double leakage-prevention device. Adapter is proof-tested against internal pressure -3 to 120 psi and external pressure 0 to 120 psi respectively for preventing leakage.

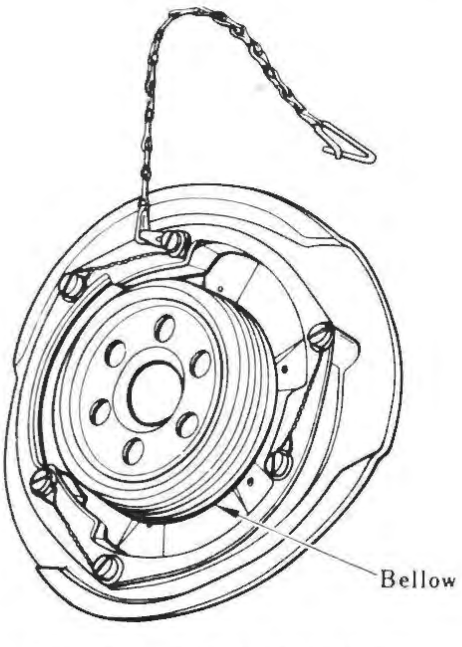
B. Drain Valve (See Fig. 5-9)

This valve is mounted directly on one side of the adapter. By opening this valve, not only the fuel within the adapter but also the fuel in the pipe leading up to the refueling shut off valve can be drained.

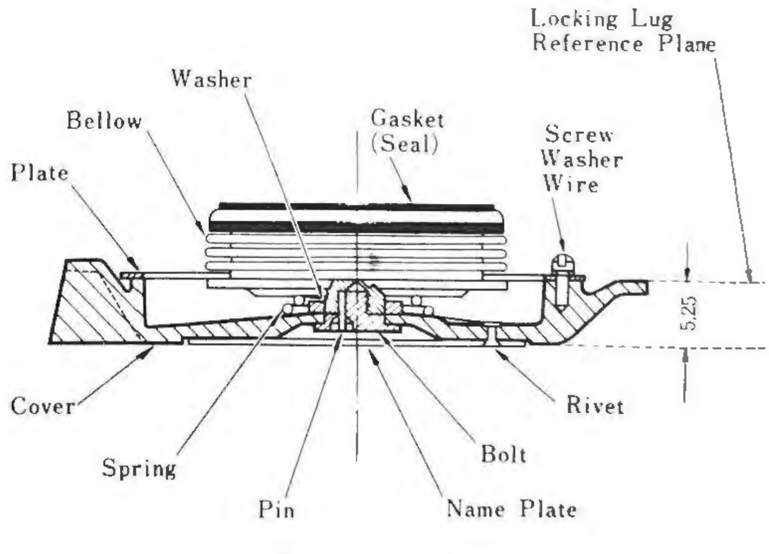








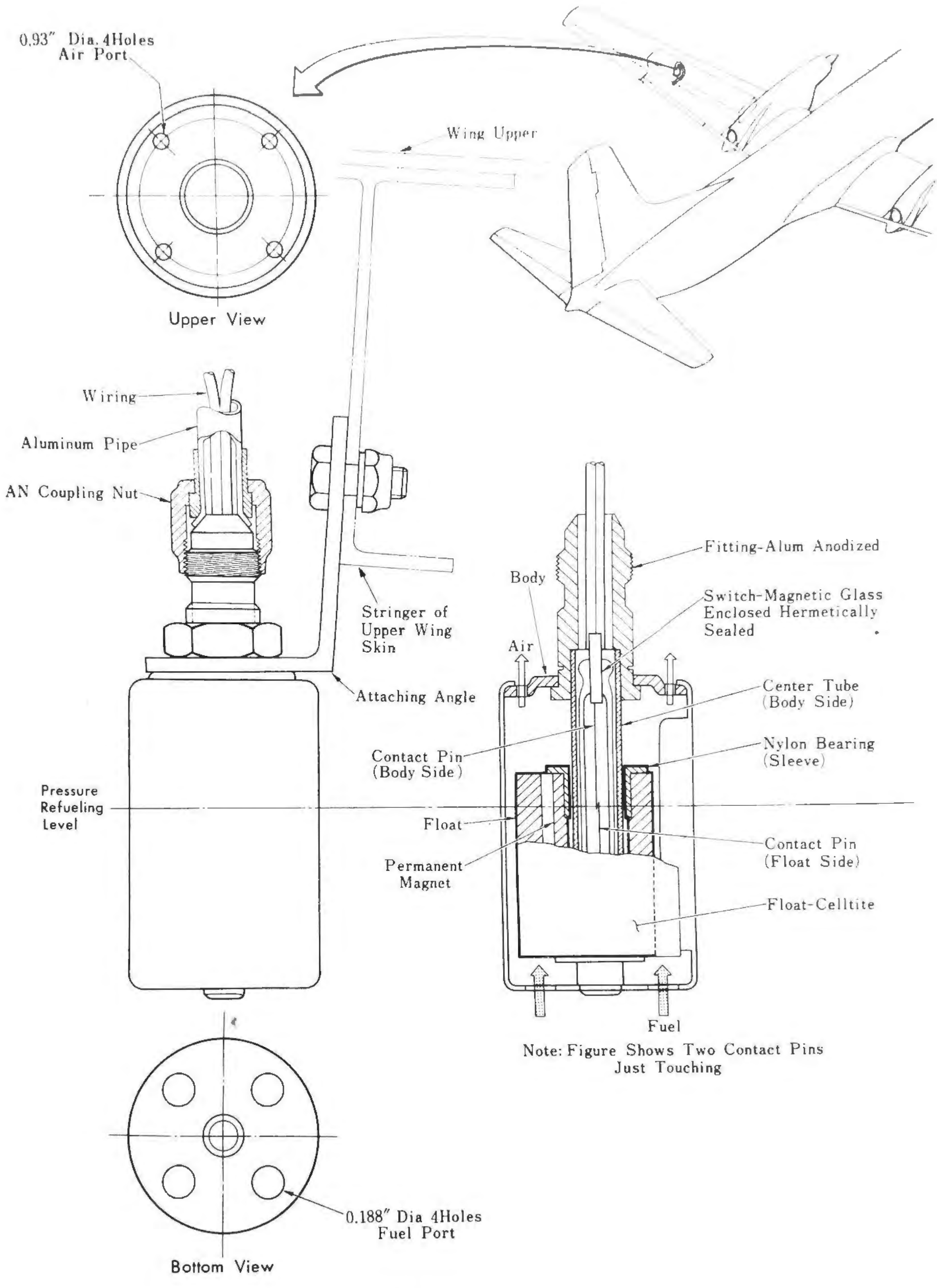
Cover Assembly Outside View



Cover Assembly

Fuel Refueling Adaptor Section View

Figure 5–9



Float Switch Section View
Figure 5–10

C. Shut-off Valve

One shut-off valve is installed in refueling line of each of the left- and right-hand side wings. This valve is electrically operated, and is to open or close the path of the refueling line.

D. Float Switch (See Fig. 5-10)

One float switch is installed in each tank. When the tank level reaches the prescribed one during refueling, the float switch actuates the refueling relays to close the shut-off valve automatically.

E. In the L.H. refueling pipe is provided an orifice which regulates the L.H. and R.H. fuel flows.

5.4 Fuel Feed System

Fuel is fed to either engine from the main tank. Fuel in the auxiliary tank is transferred to main tanks to be fed to the engines.

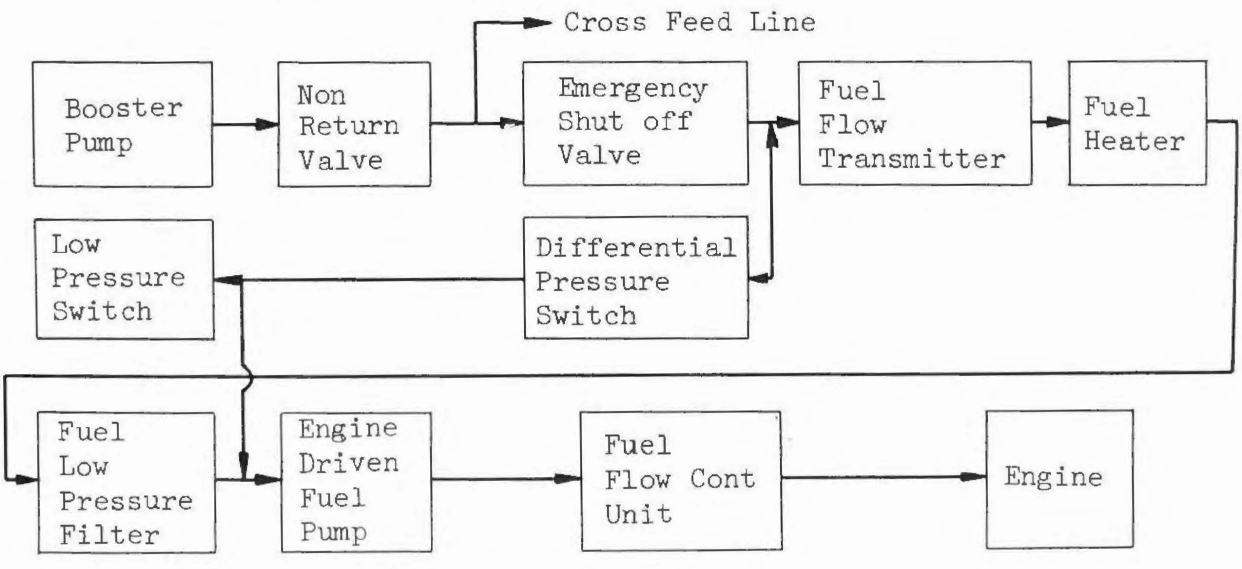
The fuel feed line consists of normal line and cross feed line.

Normal line is routed from the left-hand side tank to the left-hand engine, and from the right-hand side tank to the right-hand engine.

Cross feed line can feed the fuel from left-hand side tank to right-hand side engine and left-hand side engine as well, and from right-hand side tank to left-hand side engine and right-hand side engine as well. That is to say, cross feed lines extend from the fuel tank in either side to both engines.

5.4.1 Normal Feed Line (See Figs. 5-1 and 5-11)

The right-hand and left-hand side normal feed lines are symmetrical. In the collector tank are installed two submerged type booster pumps, one for normal fuel feeding and the other for emergency use. These two pumps are of the same type and same capacity.



Normal Feed Line Diagram

Fuel delivered under pressure from the booster pump is fed to the engine through the route as shown in Fig. 5-1.

This normal feed line is provided with the fuel de-icing system for the prevention of icing of the low pressure filter. The fuel flow transmitter has a built-in by-pass line and this normal feed line has no by-pass line. This feed line has following two pressure switches for sensing any abnormality taking place in the line.

(1) Fuel Low Pressure Switch

(2) Differential Pressure Switch

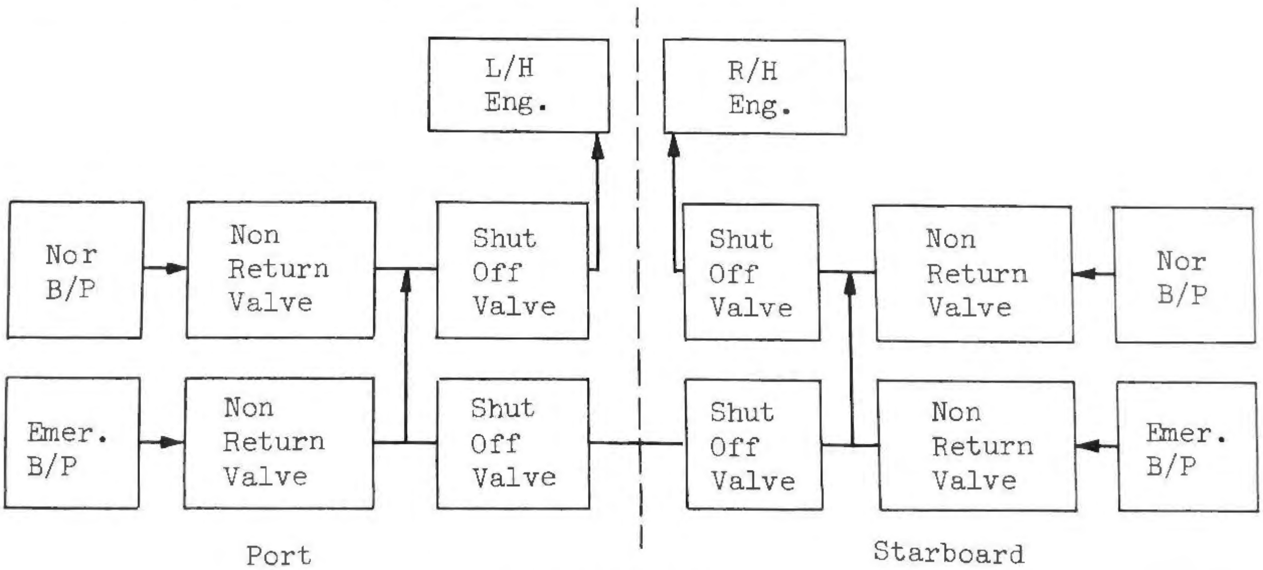
(1) Fuel low pressure switch senses pressure at outlet of low pressure filter. Fuel low pressure switch is so designed as to close the contact point when the fuel line pressure drops below 9 ± 0.25 psi, lighting the warning light (red) located on the shoulder of the fuel flow indicator on the engine instrument panel in the cockpit. Warning light goes out just before the line pressure reaches 10 psi.

(2) Differential pressure switch senses pressure difference between the upstream and downstream of low pressure filter. When difference in pressures exceeds 3 ± 0.2 psi, fuel de-icing warning light (red) comes on. The details will be described in the section of Fuel De-icing System.

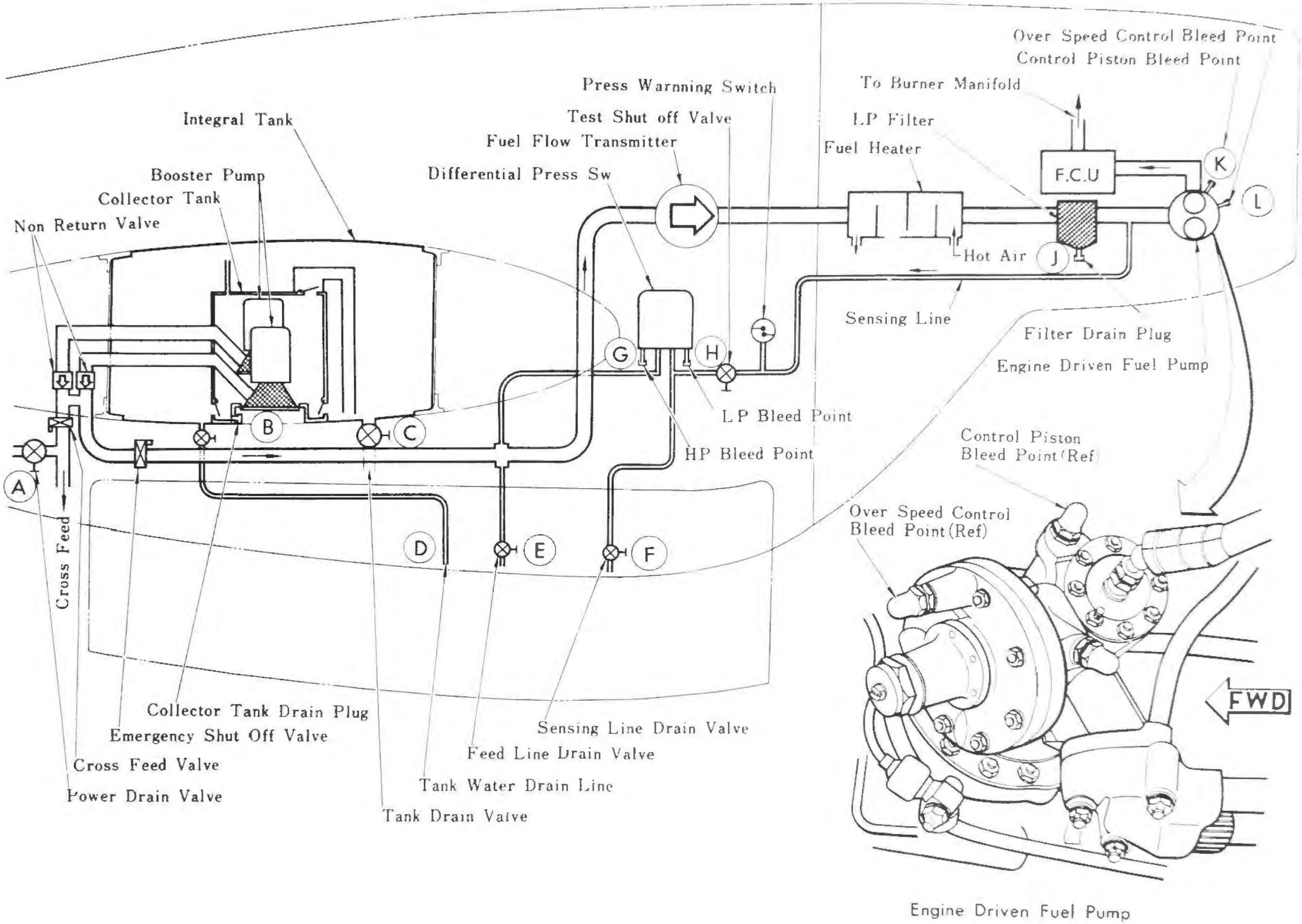
5.4.2 Cross Feed Line (See Fig. 5-1 and 5-12)

The fuel feed line is branched off into two lines at the outlet of the non-return valve of normal line, one is the normal line described above and the other is the cross feed line.

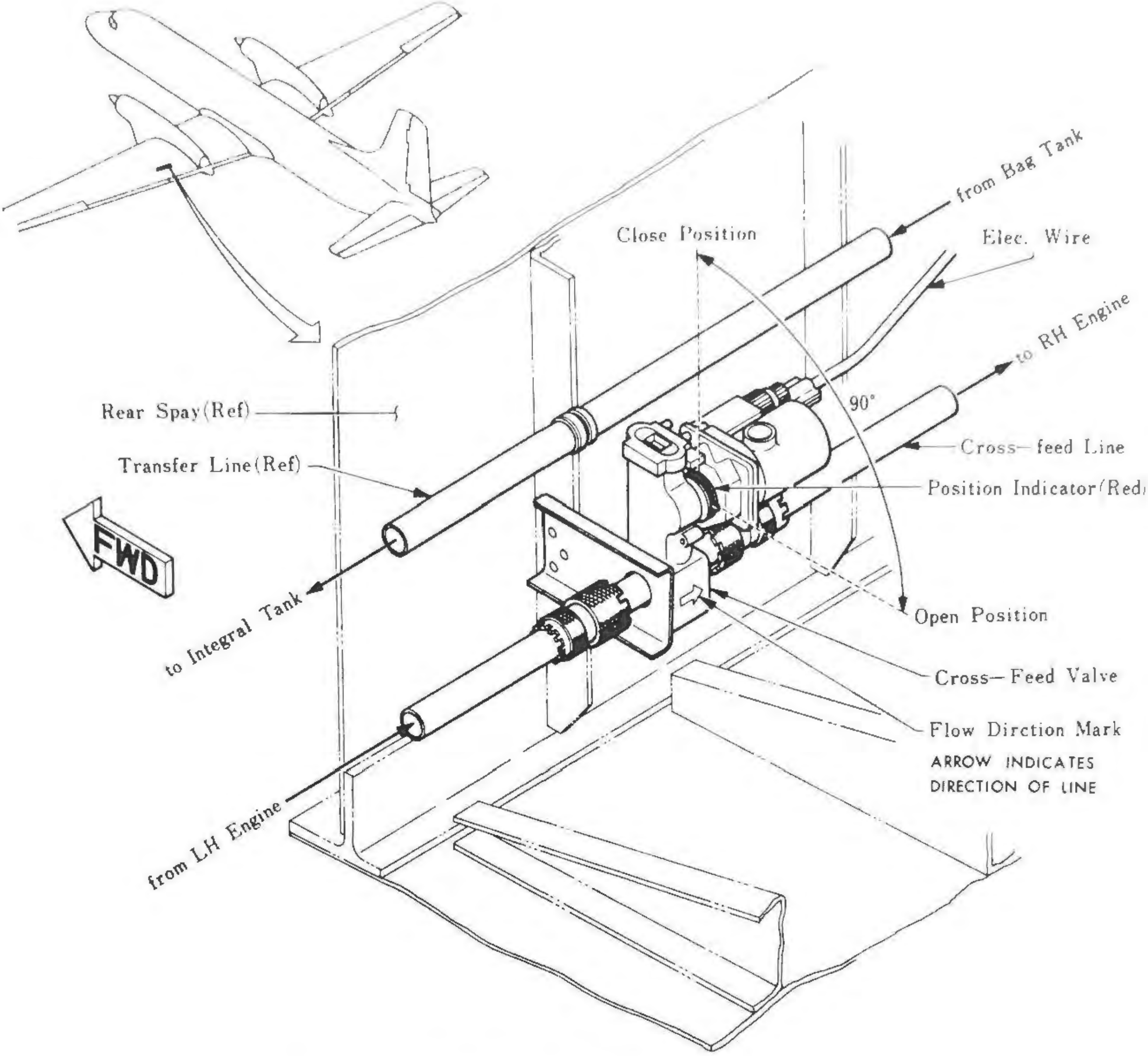
An electrically operated shut-off valve is provided for each of the right and left boards in cross feed line. Turn the cross feed switch in cockpit "ON," then the cross feed valve is opened to cross feed the fuel. During cross feed (electrically operated shut-off valve - OPEN), the valve position indicator indicates "OPEN."

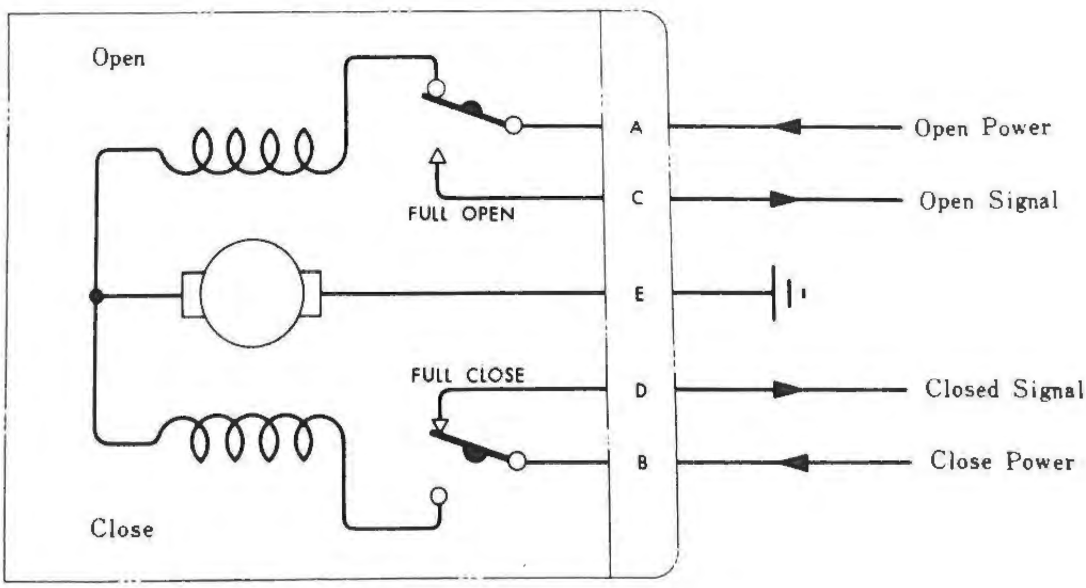


Cross Feed Line Diagram



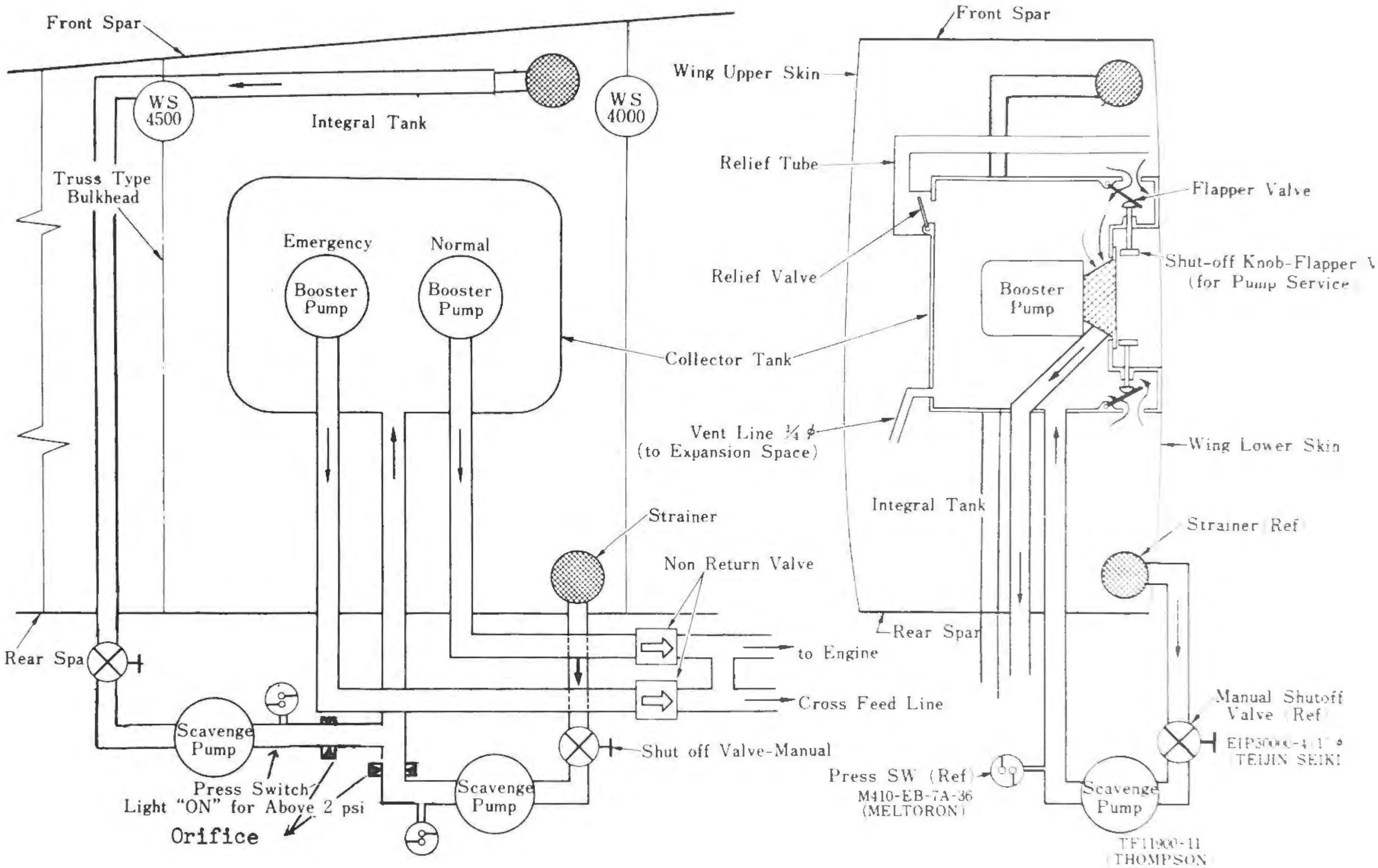
Feed System Block Diagram
Figure 5-11





Cross Feed Valve Installation

Figure 5-12

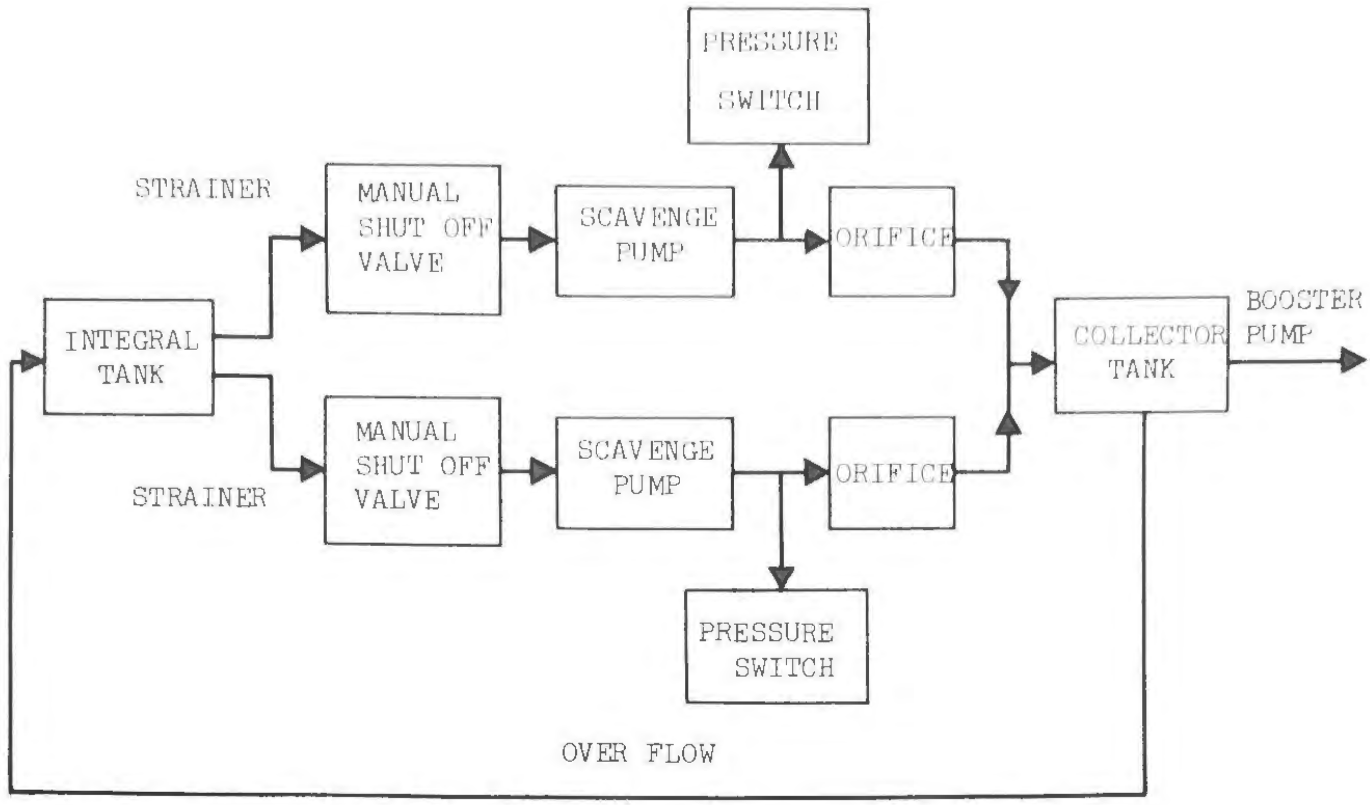


LH Collector Tank Looking from Upper

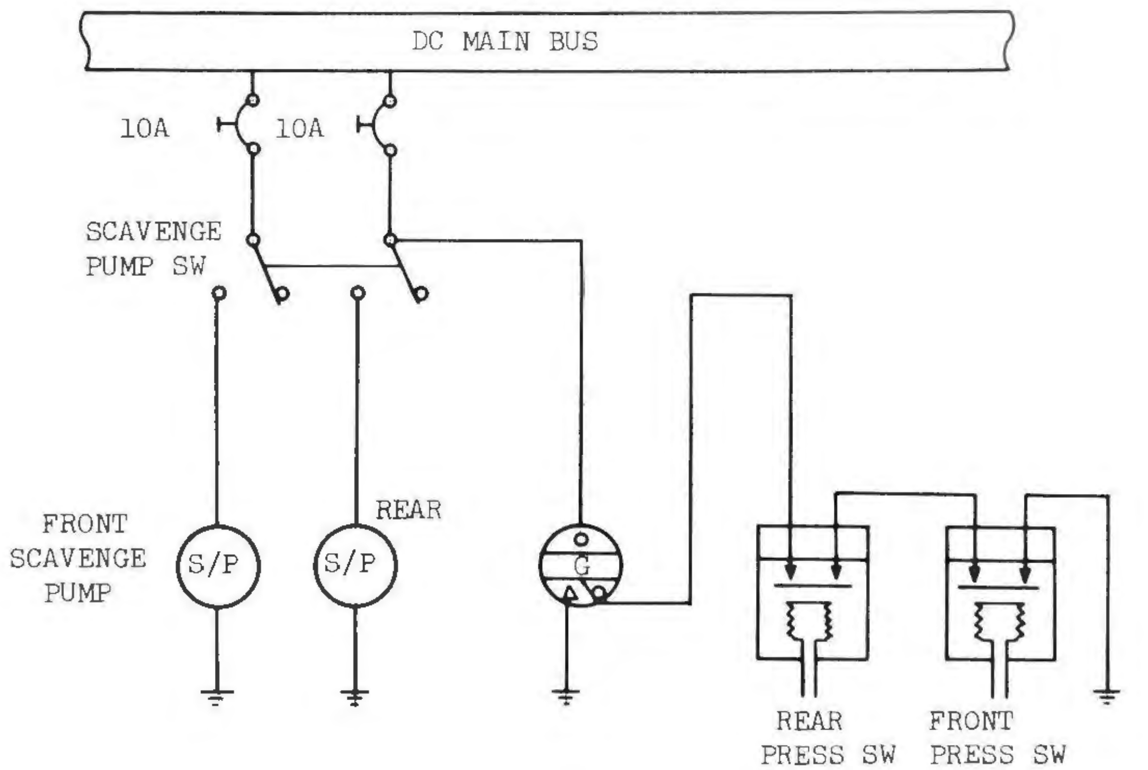
Cross Section View Looking from Inboard to Outboard

Fuel Collector Tank Schematic
Figure 5–13

Reserved



Scavenge Line Schematic



Scavenge Electric Schematic

Figure 5-13A

5.4.3 Scavenge System (See Fig. 5-13)

Each wing is provided with two scavenge pumps and the strainers between the front and rear spars. These two pumps are operated simultaneously. The duty of this scavenge system is to minimize the unusable quantity of fuel in the tank. When the fuel level in the tank has dropped, the scavenge pump, which is a kind of vane type pump, installed on the flap well outside the tank, transfers fuel in the tank to the collector tank.

The pressure switch is provided for sensing scavenge pump delivery pressure to indicate the operating condition of the scavenge system. When the pump is in operation (line pressure is over 2.5 psi), the scavenge pump indicating light (green) on the instrument panel in the cockpit comes on. The indicating light goes out if the pressure in line drops below 2.0 ± 0.25 psi.

5.4.4 Fuel System - Operation

The fuel system control panel is located on the overhead panel in the cockpit. The electrically-operated shut-off valve, pumps, etc. in the system are operated by switches on this panel.

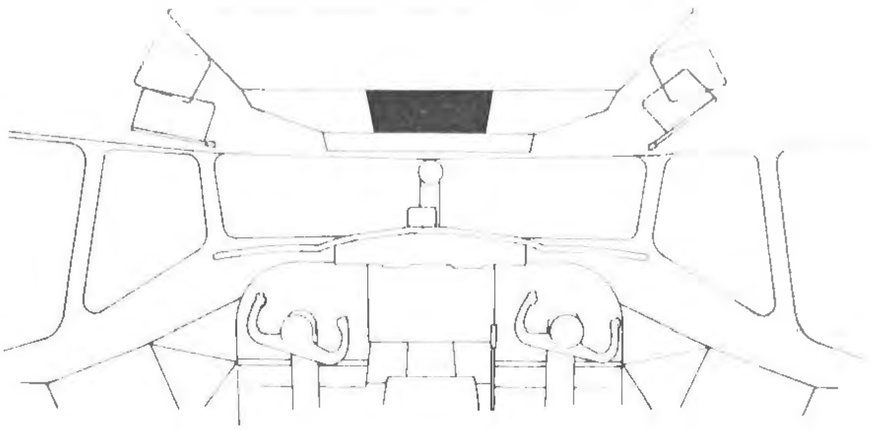
5.5 Construction and Functions of Fuel Feed System Components

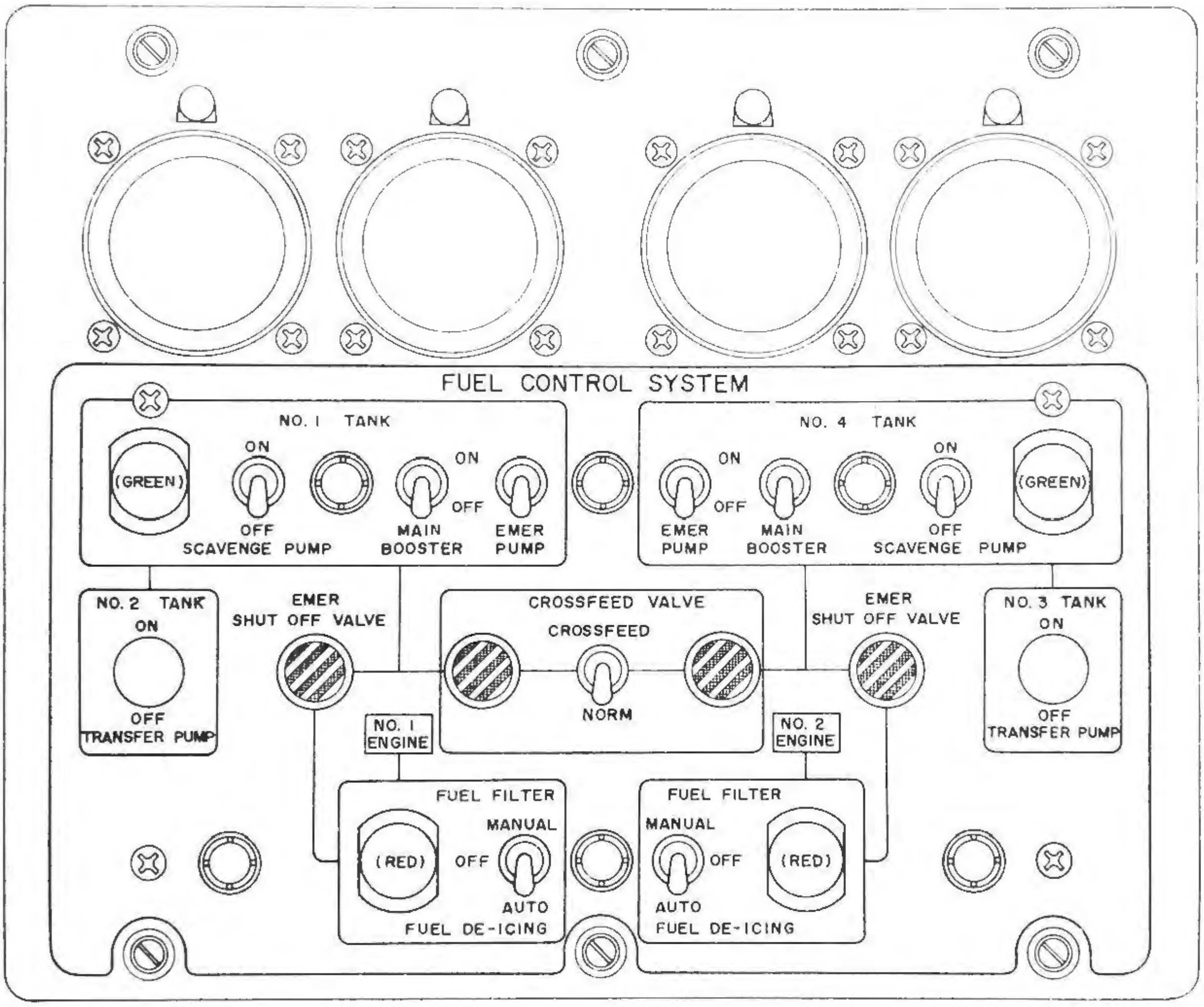
Under all expected flight conditions, the system always is capable of supplying sufficient fuel flow with necessary fuel pressure to the engines. Some examples are explained as follows.

Take-off Period: Two booster pumps, one for normal operation and the other for emergency, are installed in collector tank of each side of the wing and supplies sufficient quantity of fuel.

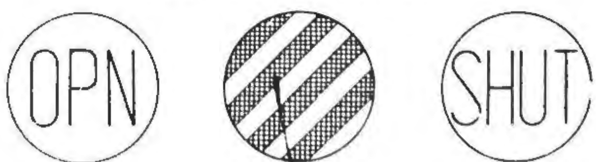
Negative Gravity Period: The system continues to feed fuel for 5 seconds (as expected from the construction of the collector tank).

Maximum Climb or Descent Attitude: A scavenge pump is provided to cope with centering of fuel to extremity when the aircraft takes this attitude.



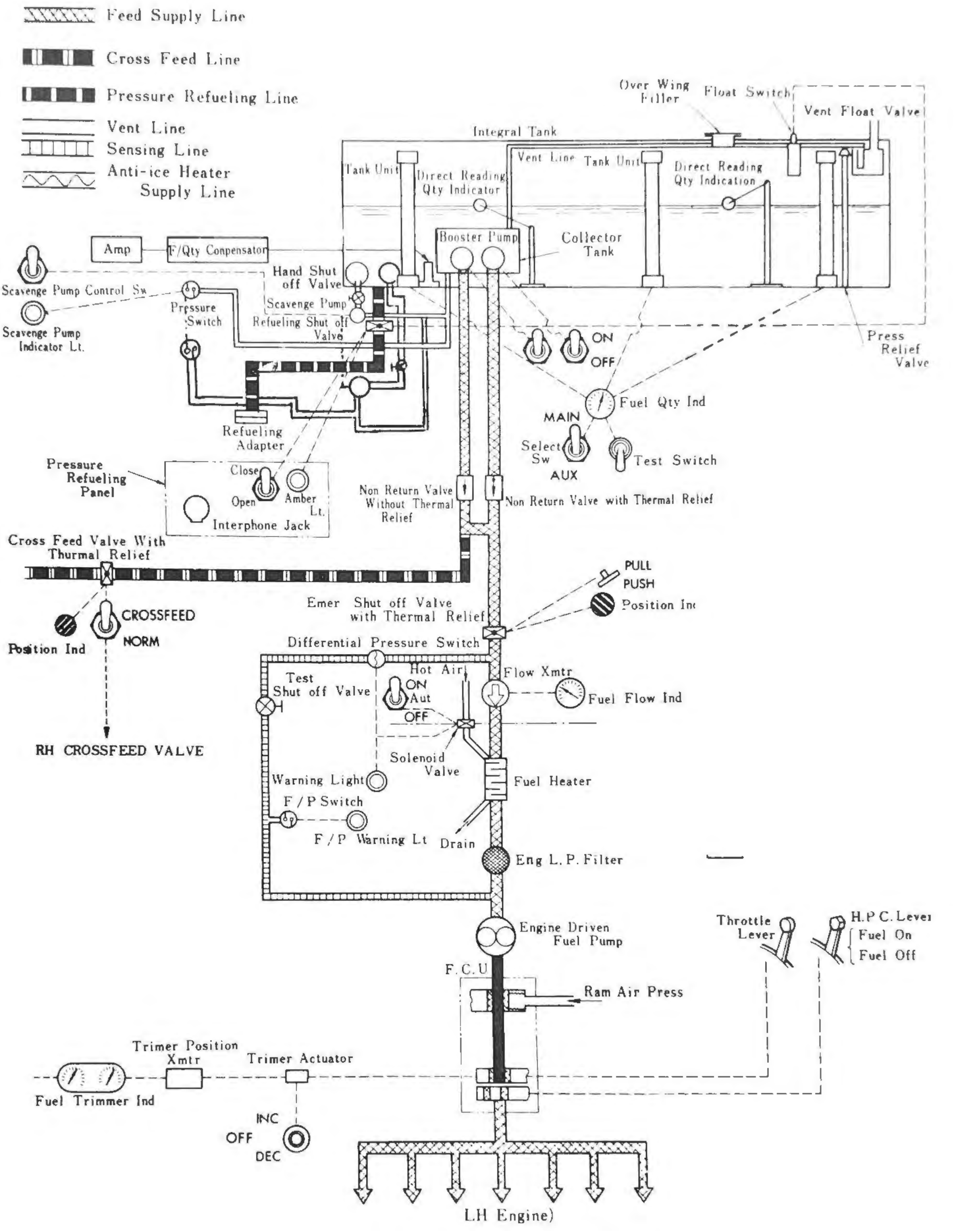


Three Position of Valve Indicator



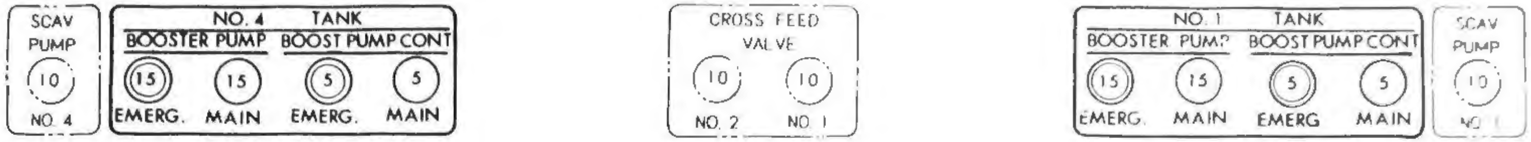
Open Neutral Shut

Fuel Control Panel
Figure 5–14

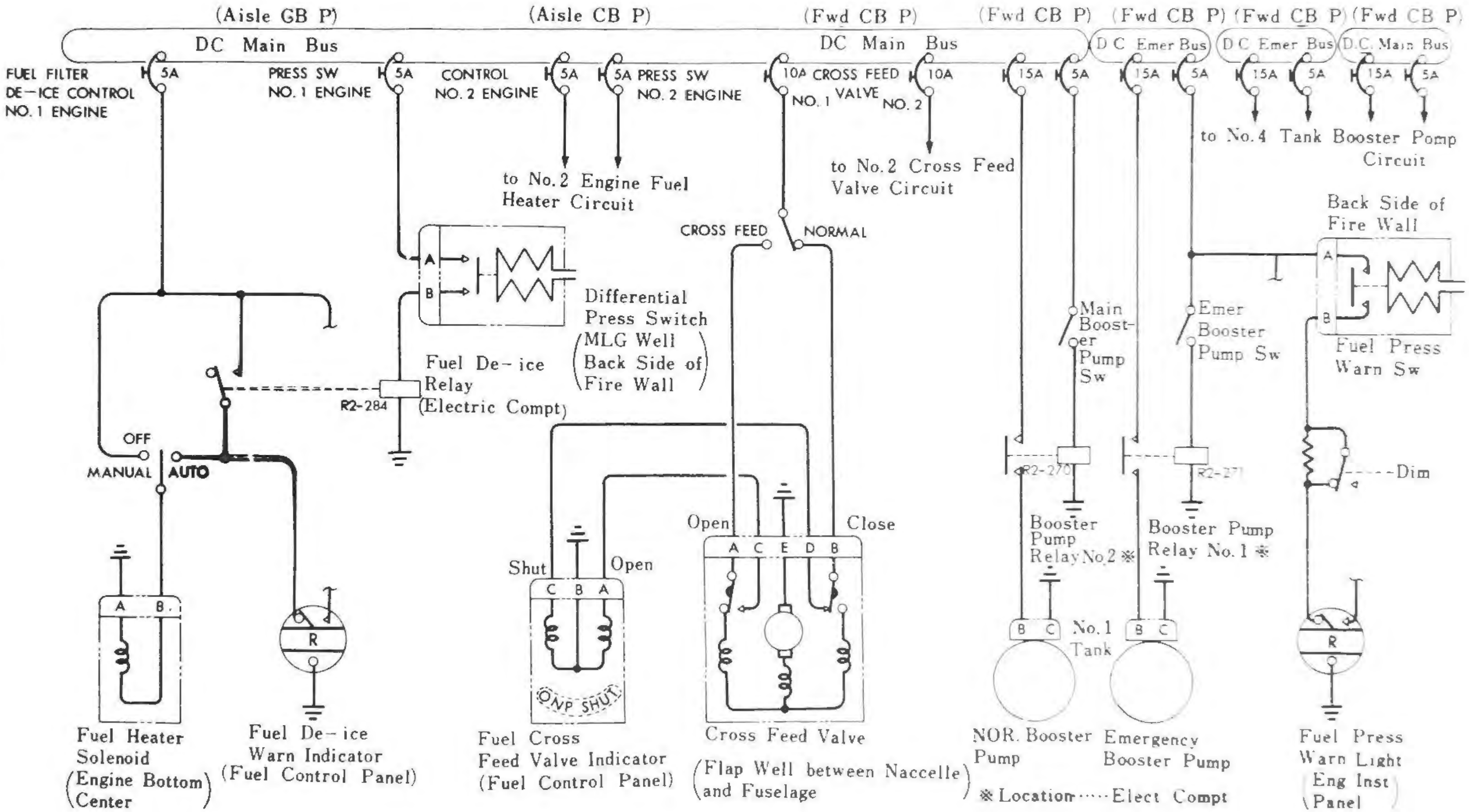


Fuel System Control Diagram

Figure 5–15



Fwd CB Panel



Fuel System Electrical Schematic
Figure 5-16

Deleted

Figure 5-17

Bank Attitude: To cope with centering of fuel to extreme position due to this attitude, the counter-flow preventing partition and the collector tank are provided.

Outside Air Temperature: Between -55°C and +57°C, the system can fully accomplish its function. For fuel de-icing and the escapement of pressure due to a temperature expansion in the sealed lines, the emergency shut-off valve, cross feed valve, non-return valve etc. are provided.

5.5.1 Feed Line Piping

The feed line piping installed on the rearward side of the main wing rear spar is made of aluminum alloy and that installed between the main landing gear well and the engine is made of stainless steel.

Pipe sizes are as follows:

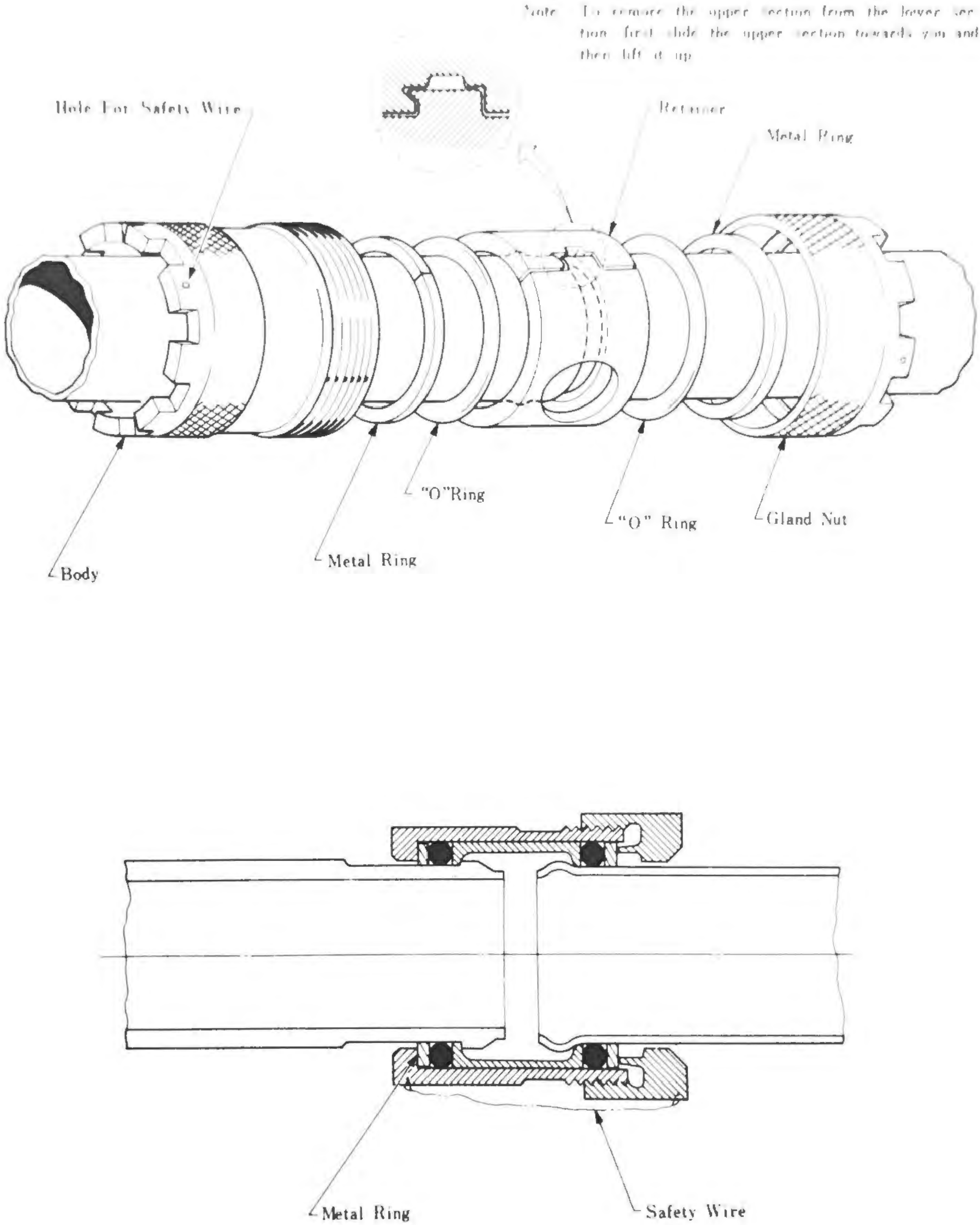
Engine Feed and Cross Feed Line	1 inch dia.
Scavenge Line	1 inch dia.
Pressure Refueling Line	1-1/2 or 1 inch dia.
Vent Line (Integral and Bag Tank)	1 or 1/2 inch dia.
Vent Line (Collector Tank)	1/4 inch dia.
Anti-icing Heater	3/8 inch dia.
Sensing Line	1/4 inch dia.
Transfer Line	1 inch dia.

As pipe coupling, AN coupling and flexible coupling are used. The former is employed for connecting pipes on the tank wall. The latter comprises wiggings flexible coupling and marman flexible coupling. Employed in the largest number is wiggings flexible coupling, which is designed to be bent in accordance with the deflection of the wing.

At the engine fire wall, the quick disconnect coupling is used to facilitate engine change.

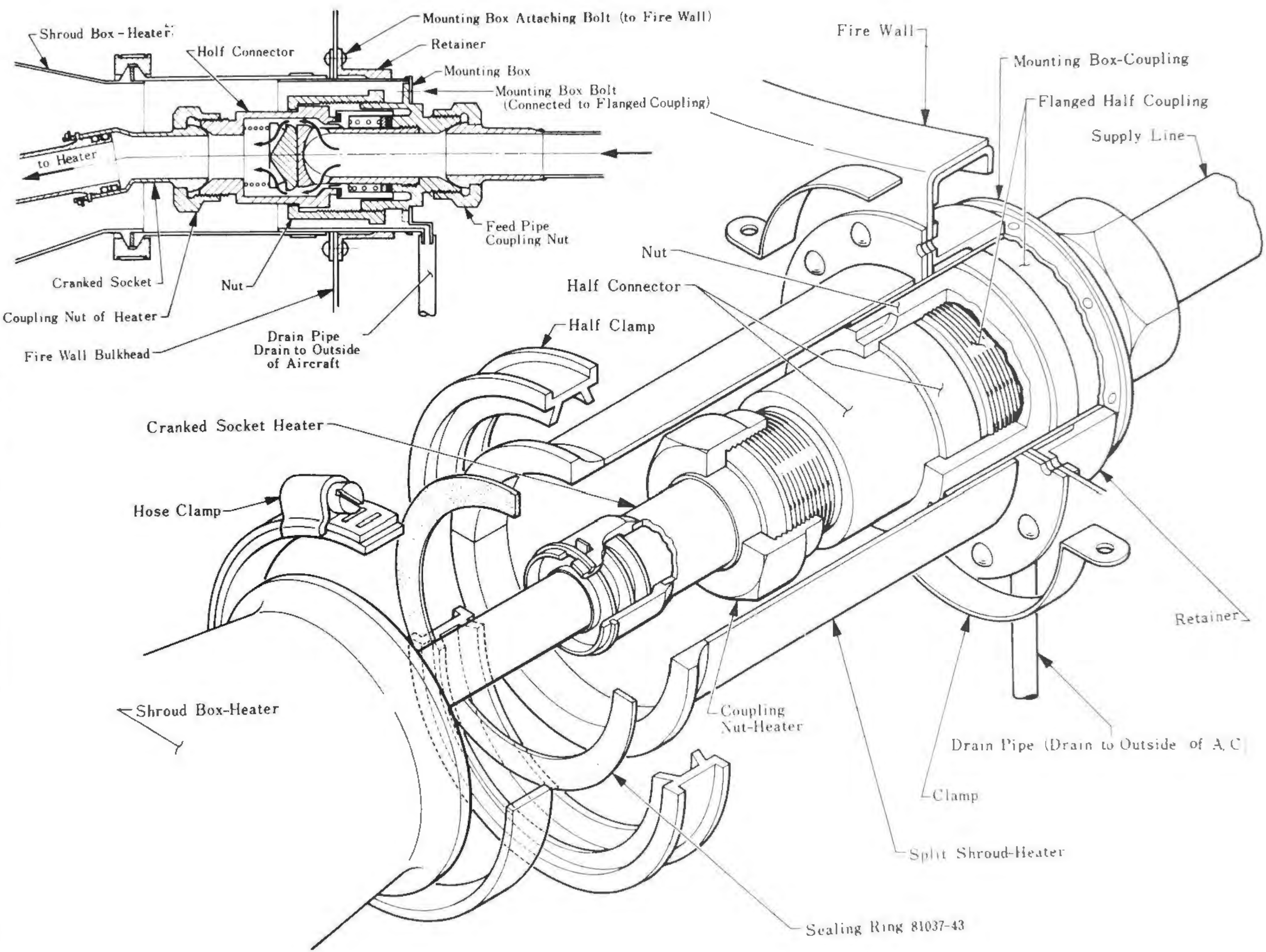
The pipe coupling in use on the tank wall is a fitting with male thread (AN coupling) on both sides of the round corner. The collar is riveted to the tank wall after face sealing treatment.

Pipe couplings installed inside the fuselage are confined in shrouds which lead fuel leaks at the coupling outside aircraft through their drain pipes.



Wiggins Flexible Coupling

Figure 5–18



Fire Wall Fuel Line Self Sealing Coupling Installation
Figure 5-19

5.5.2 Collector Tank (See Figs. 5-20 and 5-21)

The collector tank is of a square box-type isolated chamber made of aluminum alloy located at the lowest location of the integral tank.

Its dimensions are about 350 mm in width, 280 mm in depth and 360 mm in height. The tank consists of the upper and lower assemblies, which are joined together by bolts through gaskets.

In the upper assembly are installed the fuel relief tube having a flapper valve and the collector tank vent line. The flapper valve is designed to open when collector tank internal pressure accumulates above 0.05 psi than main tank pressure. The duty of this valve is to protect the collector tank from damage due to fuel delivered from the scavenge pump. The collector vent line is opened into the integral tank. In the lower assembly, the following units and components are installed:

Booster pump	2 ea.
Booster pump outlet port	2 ea.
Fuel inlet port from scavenge pump	1 ea.
Flapper valve	2 ea.
Flapper valve closing knob	2 ea.
Aluminum conduit for wiring	1 ea.

5.5.3 Booster Pump (See Figs. 5-22, 5-23 and 5-24)

The booster pump is a high-speed centrifugal pump driven by an anti-explosion type motor which operates on 27 volt D.C. power.

The pump and motor form an integral unit and are of submerged type.

Upper half of the pump incorporates an anti-explosion type motor, at lower half of the pump is installed an impeller connected to motor shaft, and at the bottom of the pump are installed radio noise filter, vent hole, pump drain hole and drain fitting for leakage in the sealed portion of the motor shaft.

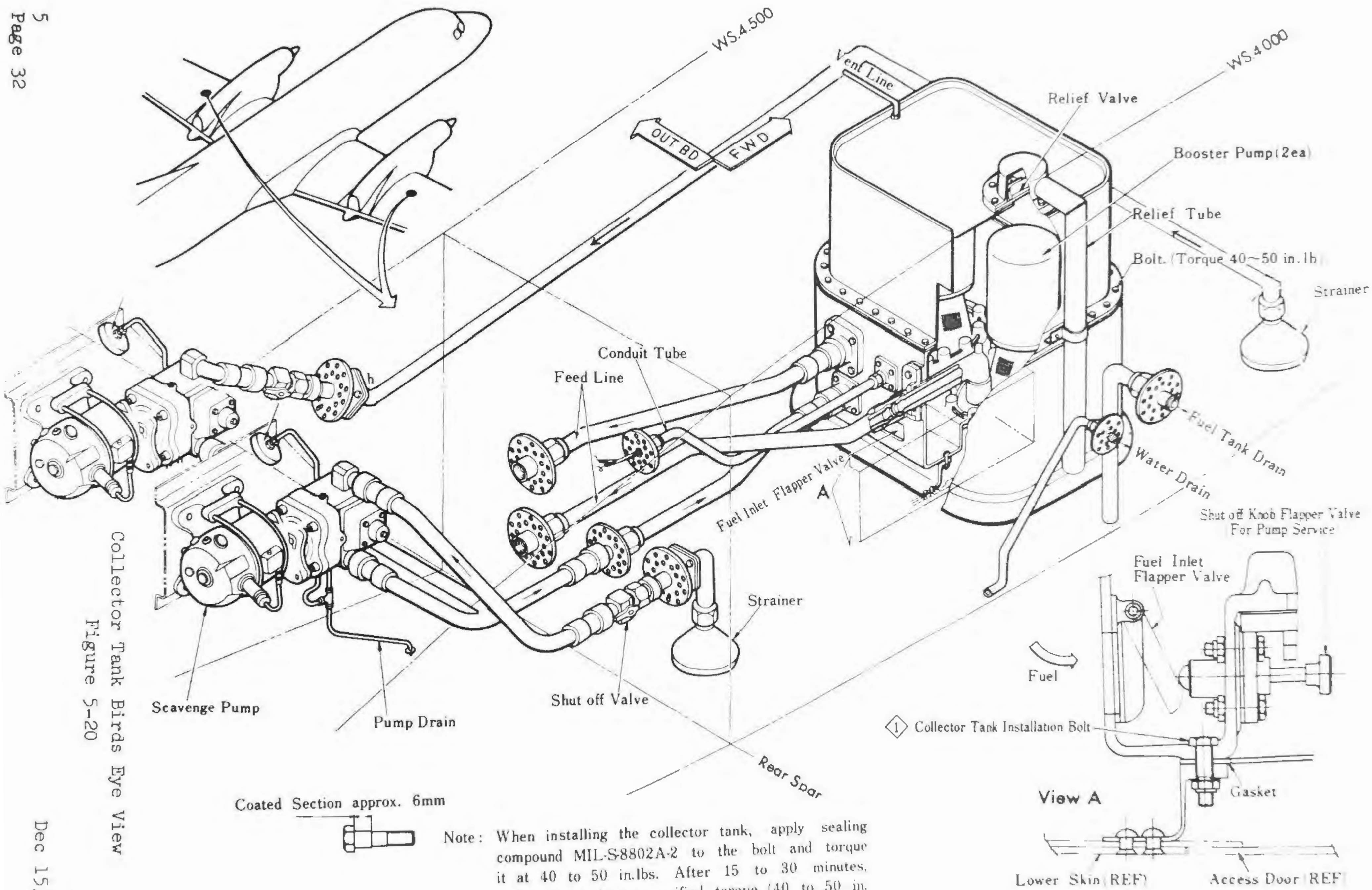
To prevent fuel from leaking into the motor room, a combination of rotating seal and fixed seal, mechanical seal and labyrinth seal is used.

A by-pass valve, which leads fuel directly to the pump outlet through the flapper valve by-passing the impeller, is installed in the pump.

During the time the impeller is in operation, bubbles come up from around the impeller. Thus vapor lock can be prevented. Two booster pumps are installed, one for normal use and the other for emergency, both of which are of entirely the same type and same capacity.

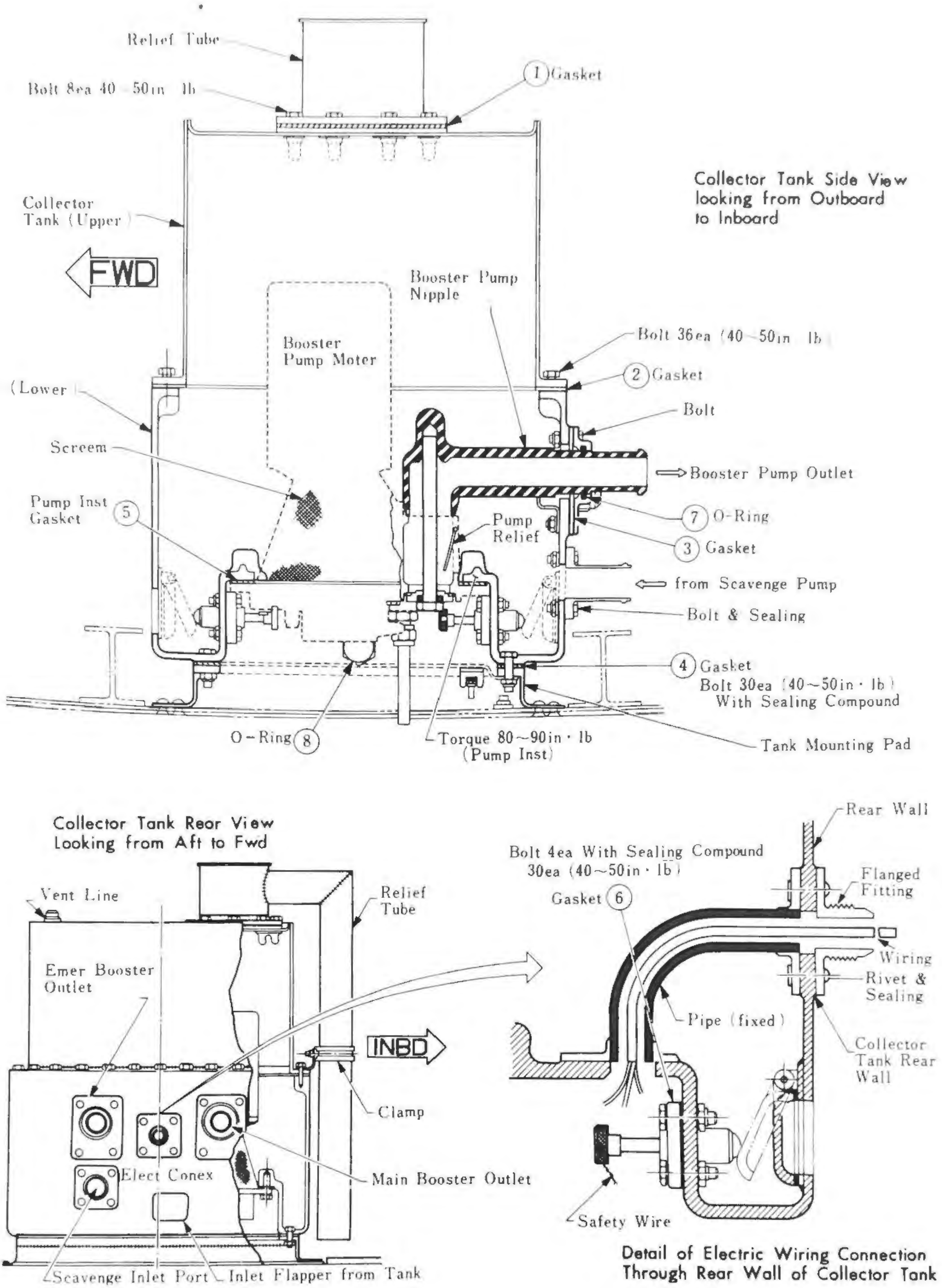
The power sources of pump motors are as follows:

For normal use	D.C. main bus
For emergency	D.C. emergency bus



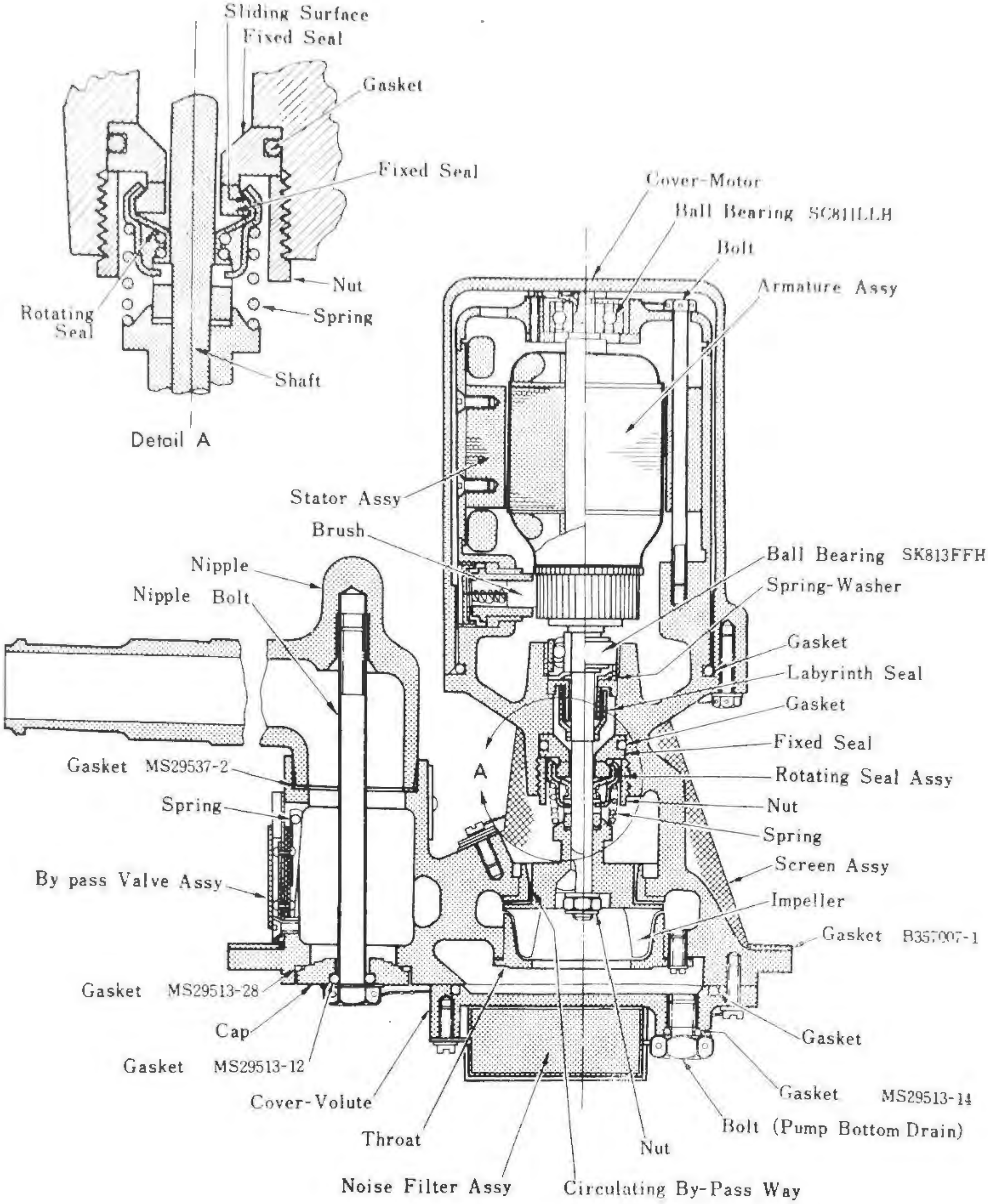
Note: When installing the collector tank, apply sealing compound MIL-S-8802A-2 to the bolt and torque it at 40 to 50 in.lbs. After 15 to 30 minutes, tighten it again to specified torque (40 to 50 in. lbs.)

Collector Tank Birds Eye View
Figure 5-20



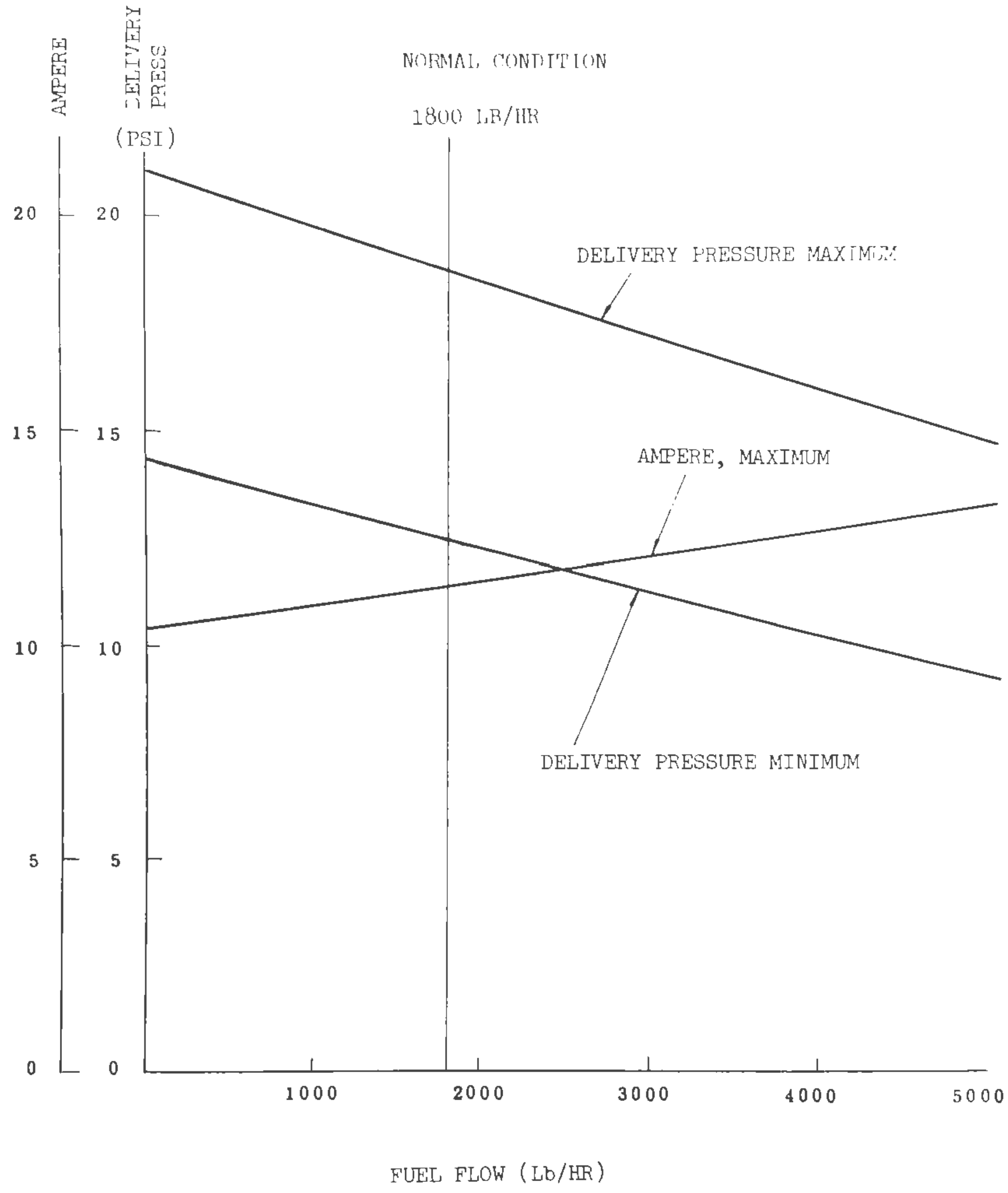
Collector Tank Installation

Figure 5-21



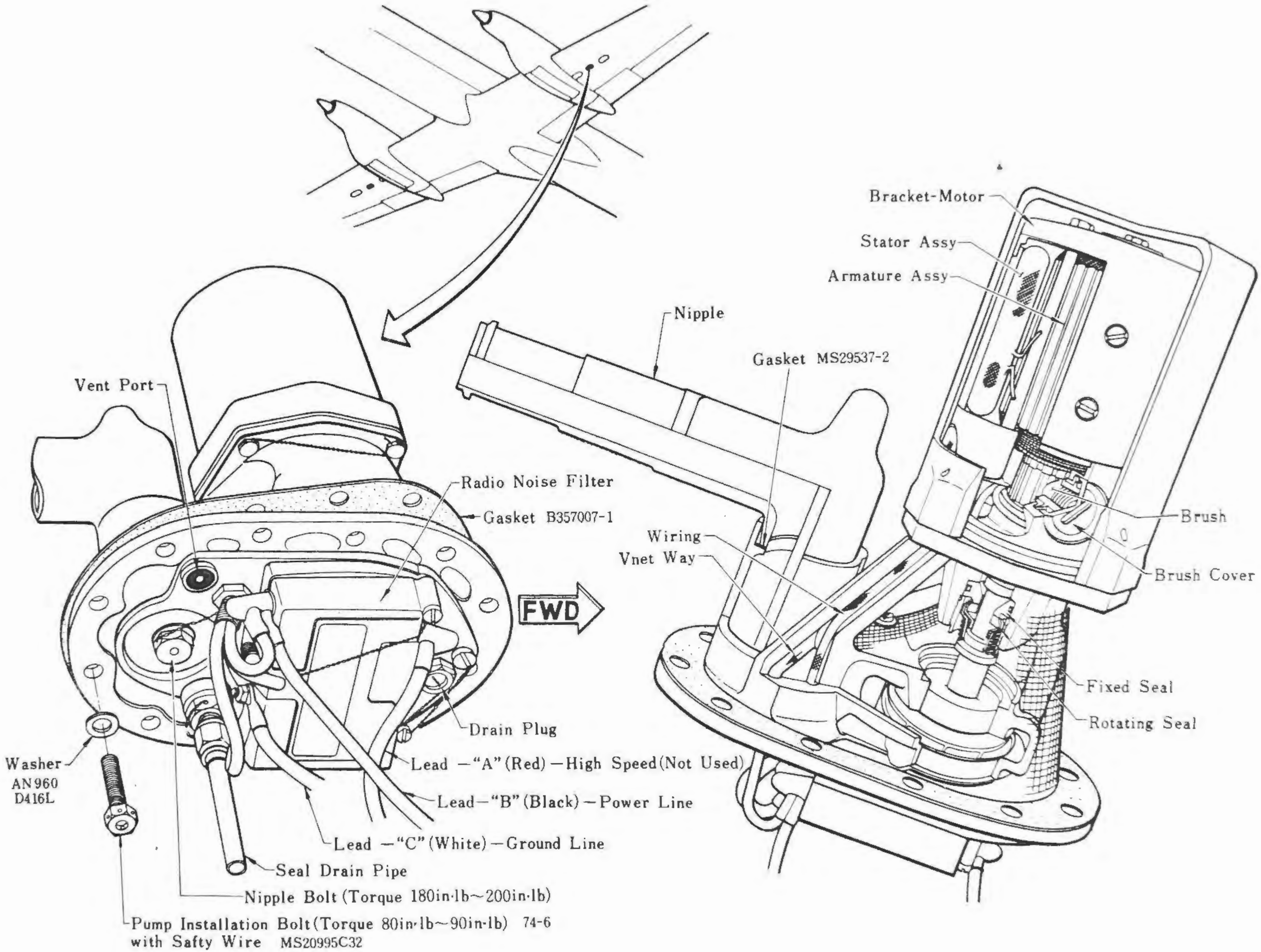
Section View of Booster Pump

Figure 5–22



FUEL BOOSTER PUMP PERFORMANCE REQUIREMENT

Figure 5–23



Booster Pump Out Side View
Figure 5-24

5.5.4 Non-Return Valve (See Fig. 5-25)

The non-return valves are installed in normal feed line, cross feed line, transfer line, etc. Pressure loss by this valve is very small, 0.5 psi even in flow corresponding to take-off period.

The non-return valve at the outlet of the normal booster pump is provided with a thermal relief hole, but the emergency booster pump has no such a hole. The thermal relief hole has an opening which can allow 40 to 60 cc/min. of fuel flow against a pressure head of 10 psi.

5.5.5 Shut-off Valve (See Fig. 5-26)

Electrically operated and manually operated shut-off valves are used in the system.

Following valves are electrically operated:

Emergency shut-off valve in normal feed line.

Cross feed valve in cross feed line.

Refueling shut-off valve in pressure refueling line.

Following valve is manually operated:

Hand shut-off valve in scavenge line

Thermal relief valves are built in the emergency shut-off valve and the cross feed valve. Outside the valve is fixed a mechanical indicator for the visual confirmation of the valve position (open or close). The body thermal relief valve relieves pressure at 120 psi and the line relief valve at 20 to 45 psi, respectively. Operating time of the valve from the full close to full open position is 0.5 to 1 second at minimum.

5.5.6 Scavenge Pump (See Figs. 5-17 and 5-27)

This pump is a vane type pump. Its delivery pressure is adjusted to 3 to 5 psi. The pump motor, a D.C. series motor, is provided with a radio noise filter.

The pump is installed in the flap well of the trailing edge of the wing outside the nacelle. The four pumps have the same functions.

Specifications of the pump is as follows:

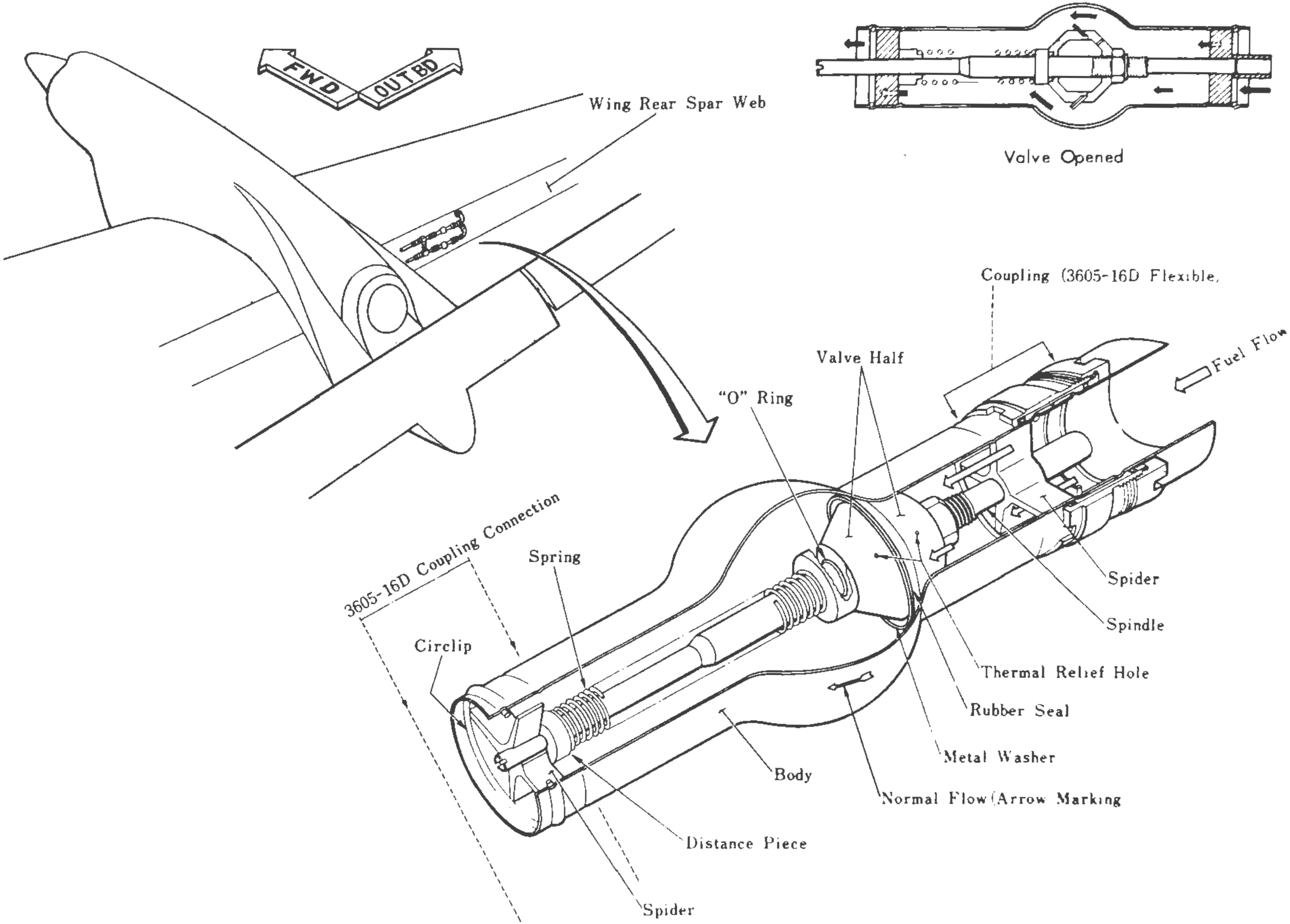
Flow rate	2200 lbs/hr
Delivery pressure	3 to 5 psi
Suction pressure	1.5 m Hg

A scavenge pressure switch which senses scavenge pump fuel pressure is installed in the flap well. The function of the scavenge pressure switch is such that the scavenge indicating light (green) comes on when the pressure exceeds 2 psi and the light goes out when the pressure drops below 2 ± 0.25 psi. Therefore, if the pressure of one pump goes down below 2 psi, both lights go out.

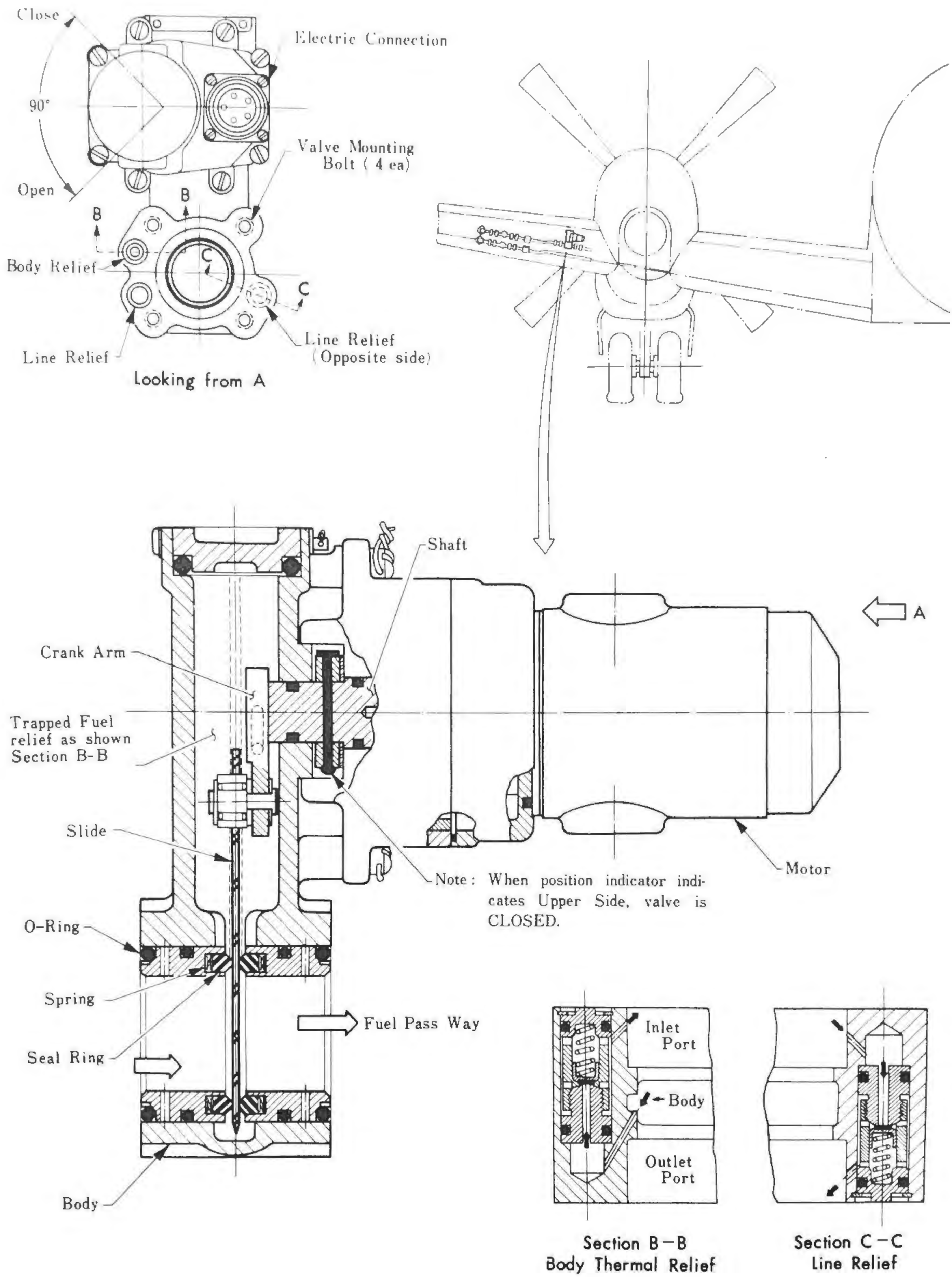
5.5.7 Drain Valve

The drain valves in the tank and fuel lines consist of the following:

Pipe dia.	Part Number	Name of the valve	Q'ty
1/4 inch	KIF20000-1	Cross Feed Line Drain	3
		Pressure Refuel Drain	1
		Sensing Line Drain	2
1/4 inch	KIF20000-6	Fuel De-icing Test Shut-off	2
		Integral Tank Water Drain	2
1 inch	EIP30000-1	Scavenge Inlet Shut-off	4
1 inch	EIP30000-4	Fuel System Power Drain	1
1 inch	EIP30000-5	Integral Tank Drain	2

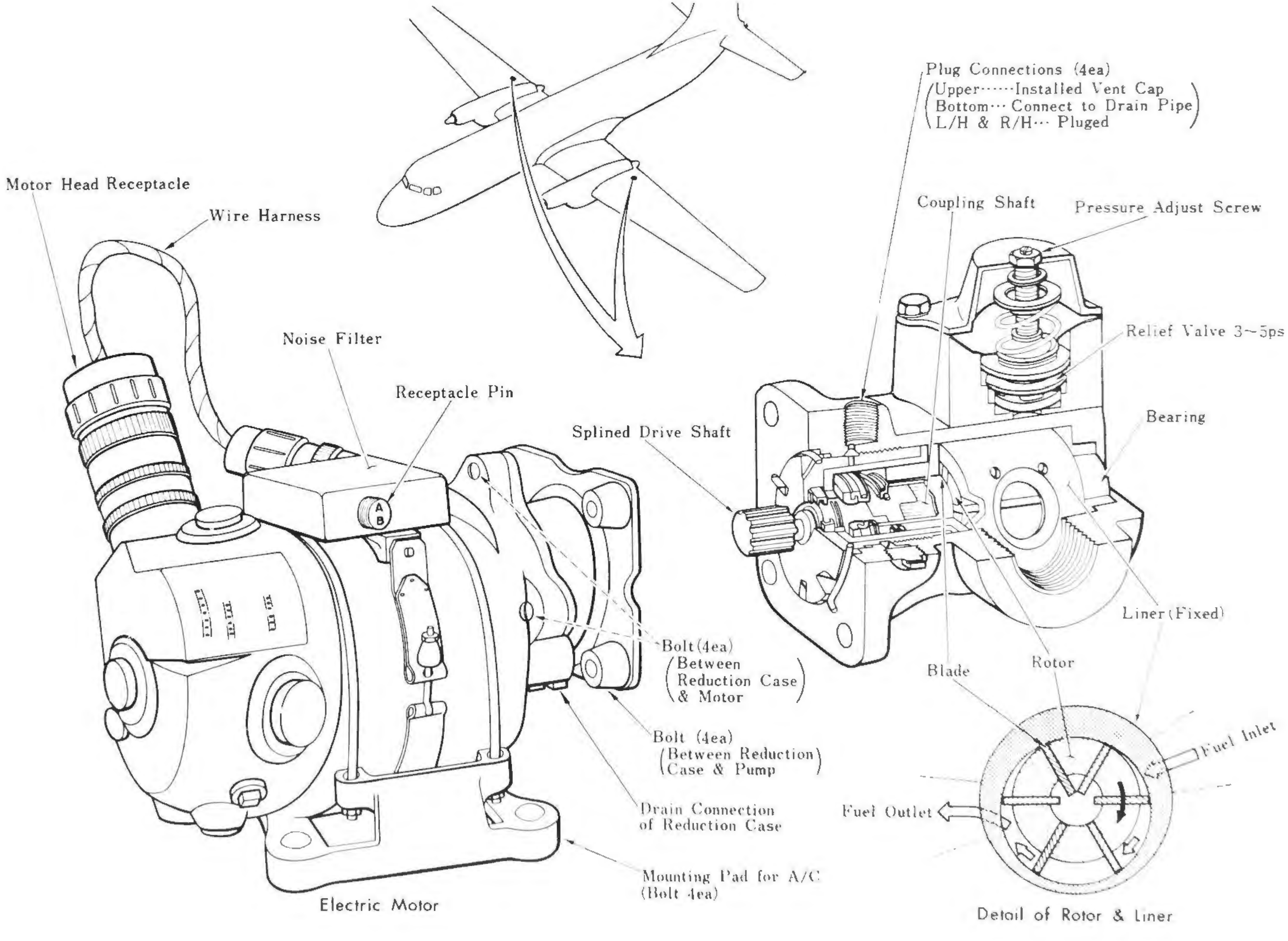


Non-Return Valves
Figure 5-25

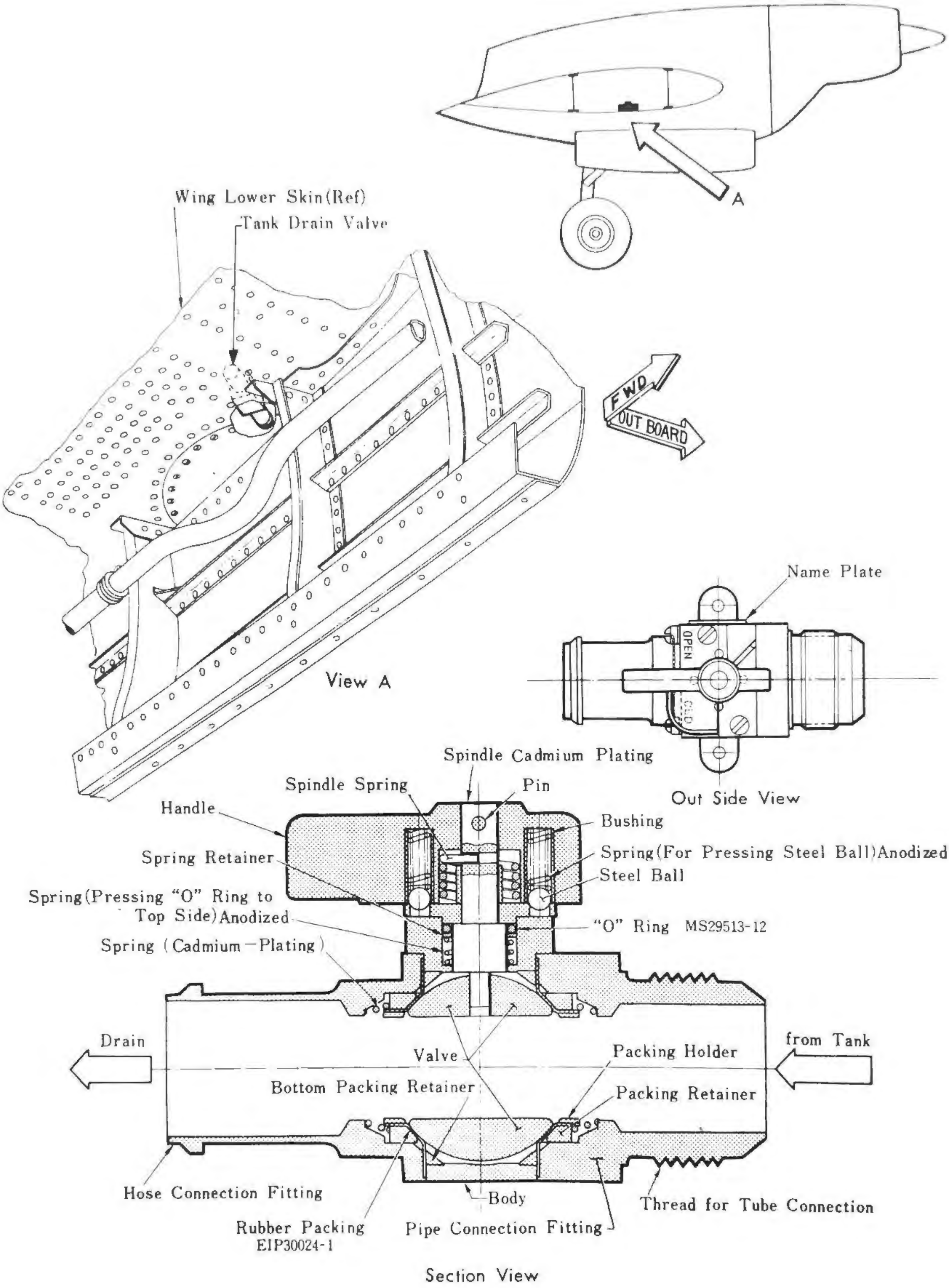


Fuel Emergency Shut-off Valve Cross Section View Schematic

Figure 5–26



Fuel Integral Tank Scavenge Pump Cut-Away
Figure 5-27



Fuel Tank Drain Valve

Figure 5-28

5.6 Fuel De-icing System

5.6.1 Functions

The fuel heater is installed on the fuel feed line to prevent the fuel from icing and choking the low pressure filter. Heat source of the fuel heater is the bleed air from the second stage of the engine. In the bleed air line the solenoid valve (bleed air gate valve) is installed.

Icing and choking at the low pressre filter is detected by the pressure difference between the up-stream and down-stream of the filter. Pressure in the up-stream is sensed immediately before the fuel flow transmitter while that in the down-stream is sensed at the outlet of the low-pressure filter.

When this pressure difference exceeds 3 ± 0.2 psi, the pressure switch in the sensing line closes its contact point to light the fuel de-icing warning light (red) on the upper instrument panel in the cockpit.

Hot air extracted from the second stage of the engine passes through hot air valve and flows into the fuel heater to perform de-icing.
About 4% of the power delivered from the engine is consumed to perform de-icing by the hot air.

5.6.2 Switch Position

The gate valve on the bleed air line performs three missions according to the control switch positions in the cockpit.

Control Switch Position

OFF .... Engine bleed air does not flow even when fuel de-icing warning light is on. (Heater is not in operation)

Gate valve is always CLOSED.

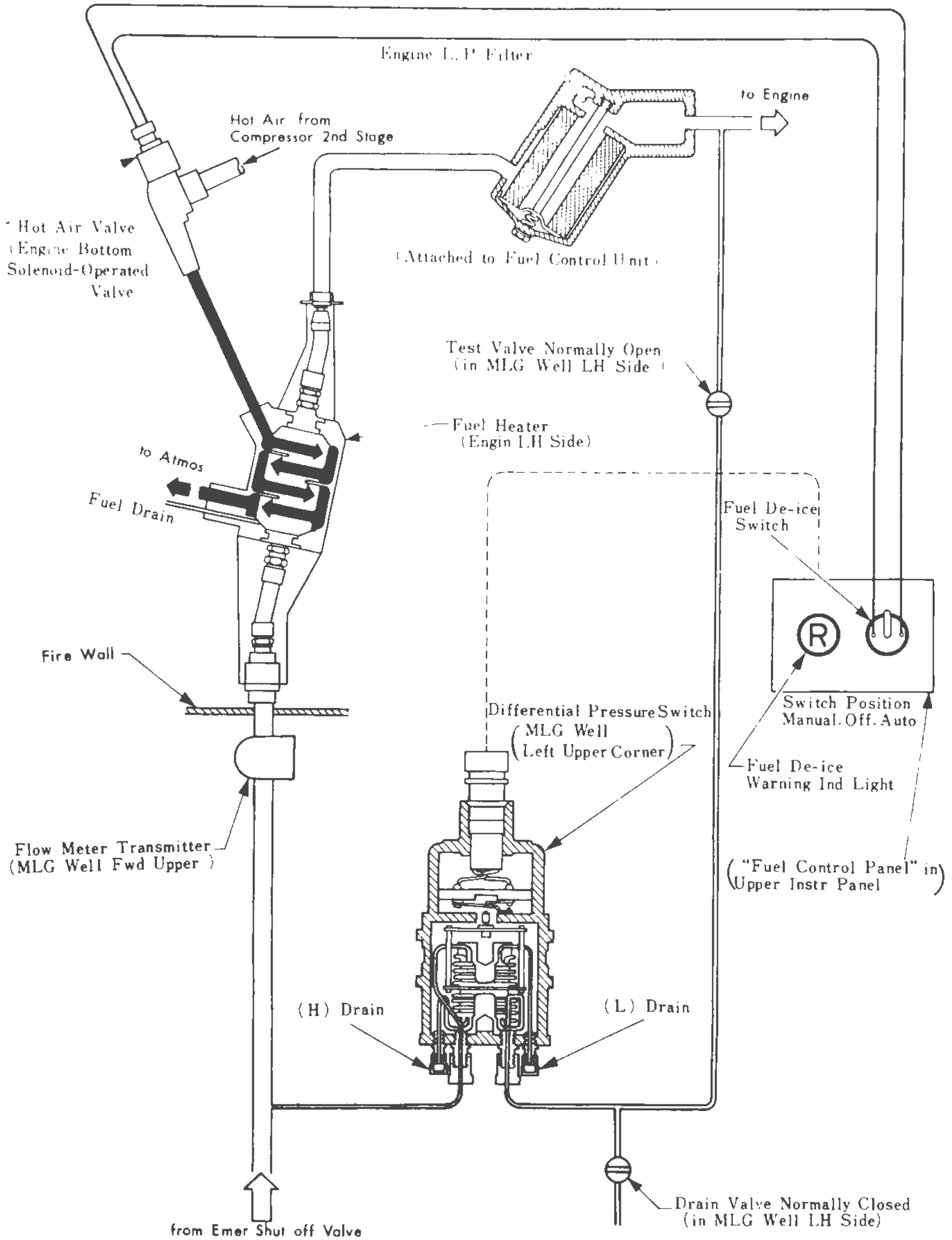
Auto .... Engine bleed air starts flowing automatically and simultaneously when fuel de-icing warning light comes on. (Heater is in operation.)

Gate valve is OPEN

Manual .... Engine bleed air flows even when fuel de-icing warning light is not on. (Heater is in operation)

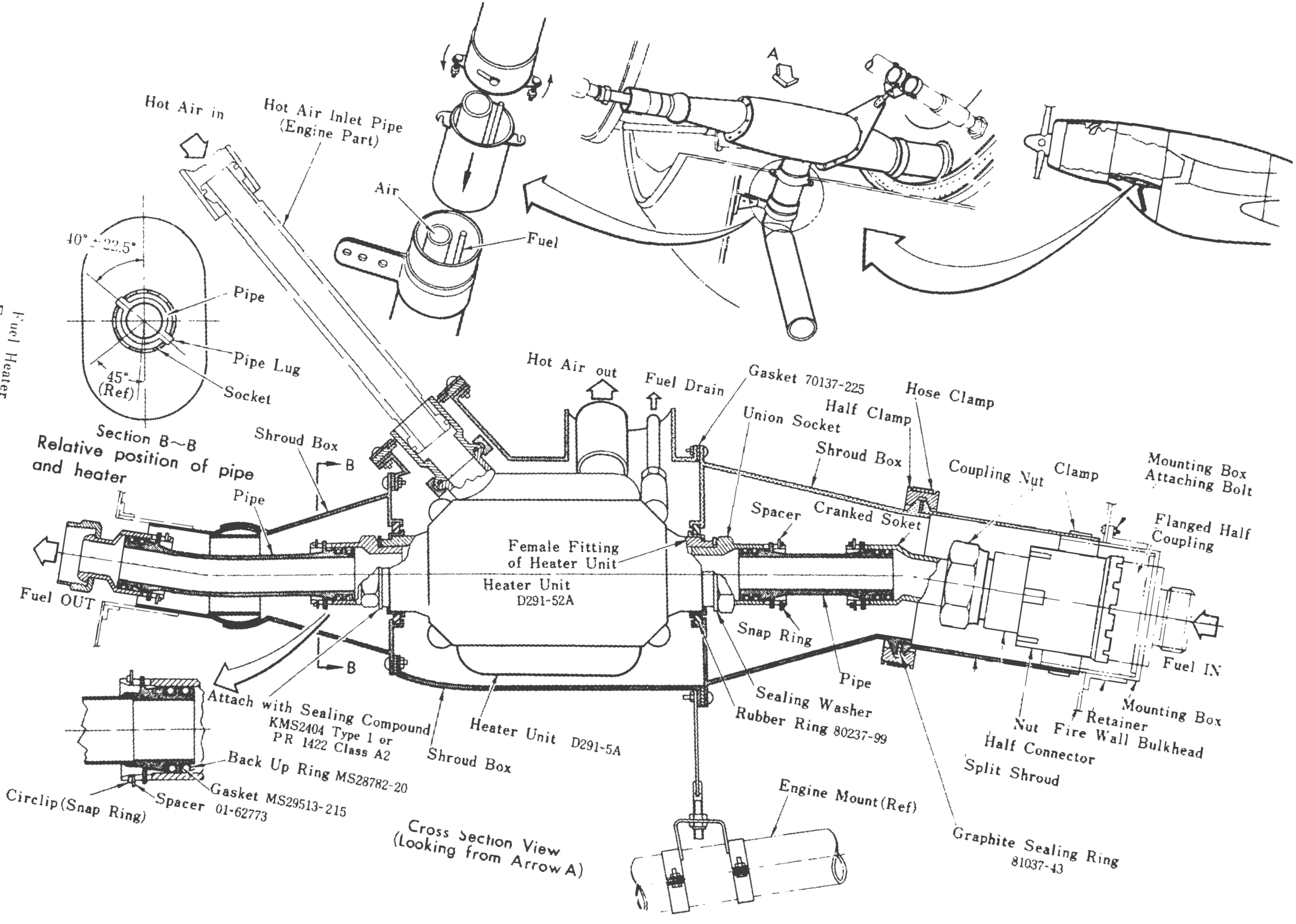
Gate valve is always OPEN.

The fuel heater is of such a construction that the fuel passage is straight and the engine bleed air crosses the fuel flow line at the right angle.

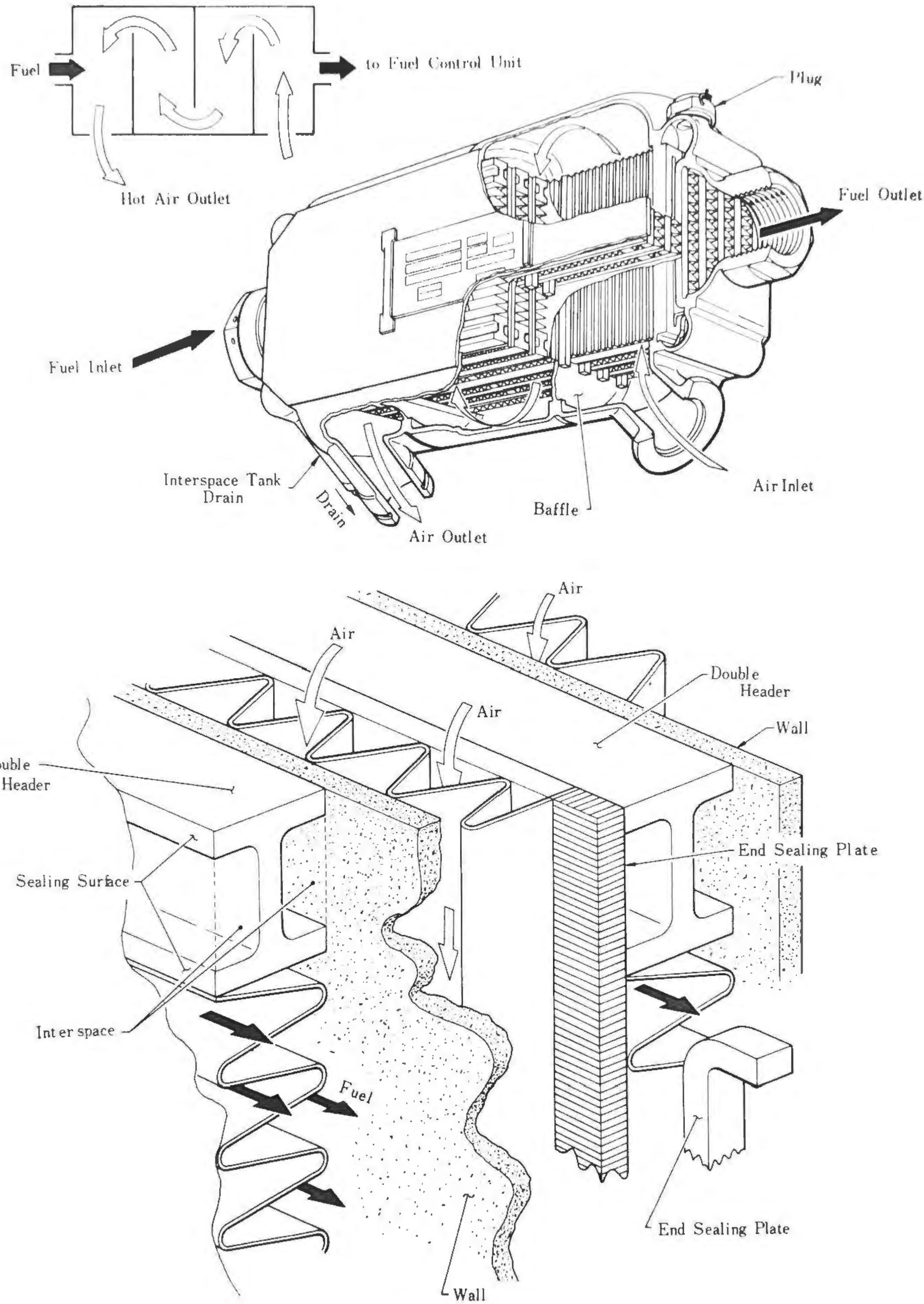


Fuel Heating (Engine Filter De-icing) and Warning Control Schematic

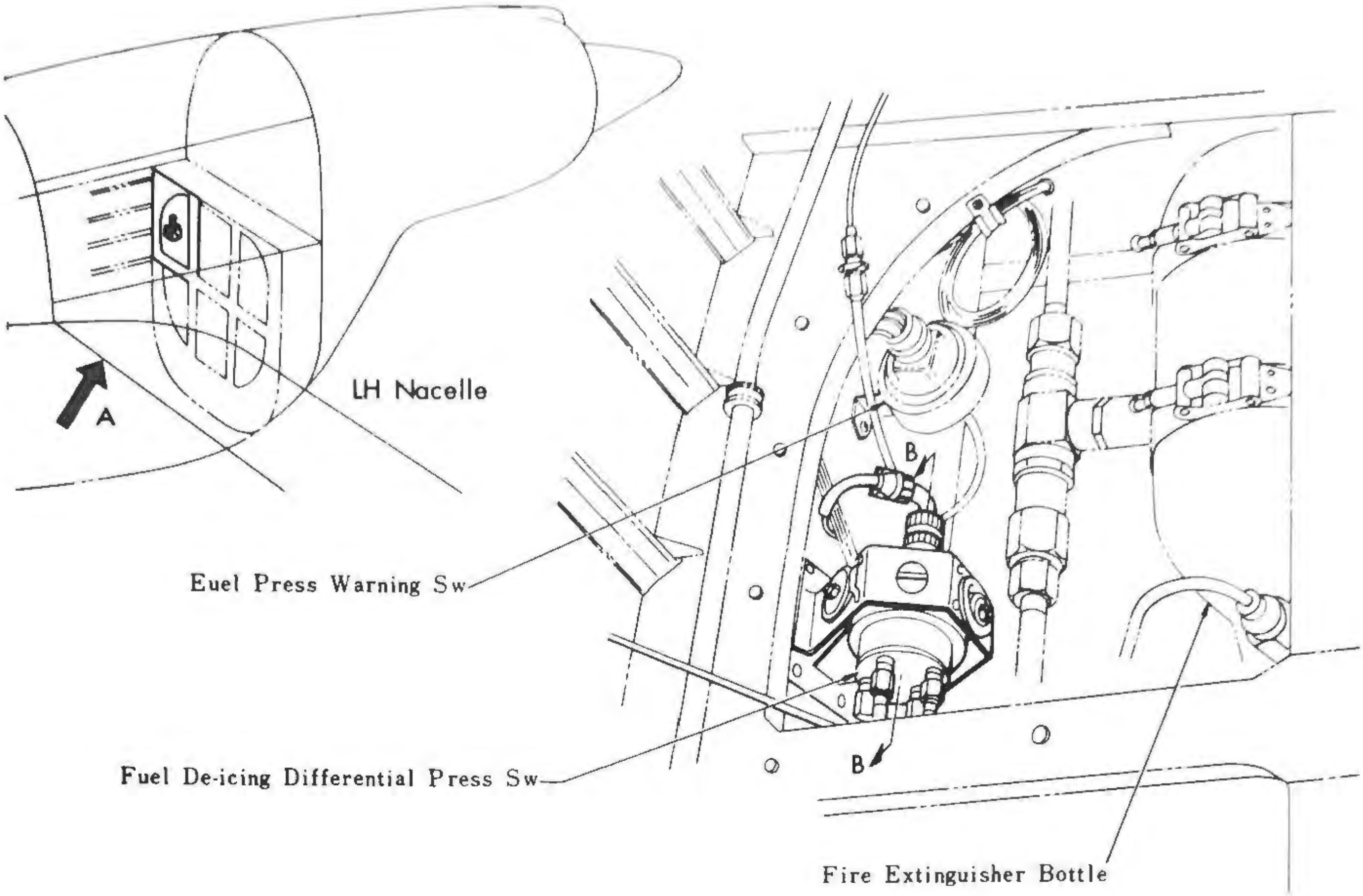
Figure 5–29



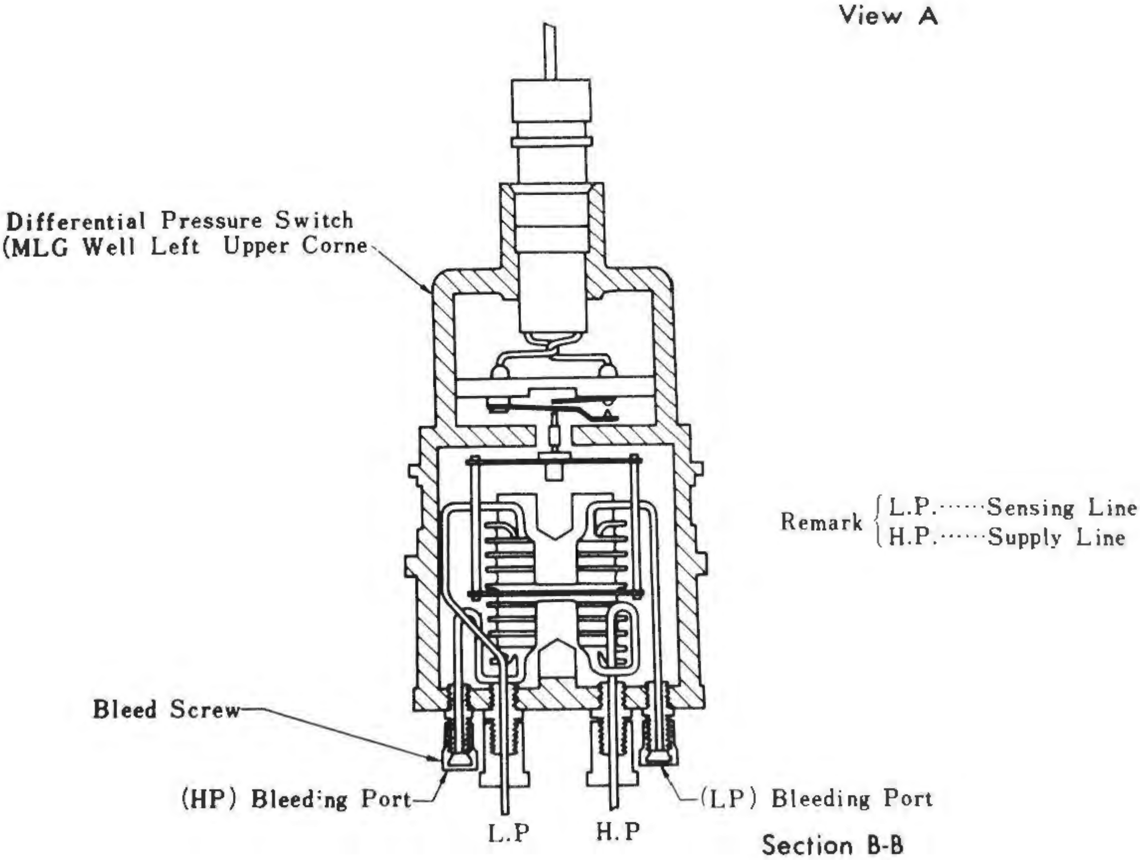
Fuel Heater
Figure 5–30



Fuel Heater Construction
Figure 5-31



View A



Section B-B

Fuel De-icing Differential Pressure Switch
Figure 5–32

5.6.3 Major Components of Fuel De-icing System

(1) Fuel Heater Unit

(2) Differential Pressure Switch

(3) Hot Air Valve

(4) De-ice Switch

The fuel de-icing system is operated by above-mentioned major components automatically or manually.

On airplanes #62 and later are provided the fuel temperature indicating system which has a fuel temperature bulb in the F.C.U. filter to sense the fuel temperature, sending signals to the dual type gauge on the R/H side panel. Thus, the reference temperature for fuel de-icing operation is changed from O.A.T. to the fuel temperature.

5.7 Fuel Quantity Indicating System

Two kinds of fuel quantity indicators are employed.

(1) Direct-reading fuel quantity indicator designed to indicate the volume of fuel.

(2) Fuel quantity indicator designed to indicate the weight of fuel.

5.7.1 Direct-Reading Fuel Quantity Indicator

This type of fuel quantity indicator is installed only in No. 1 and No. 4 fuel tanks, on the manhole cover plates at W STA 4800 and W STA 8000 of the lower surface of the wing, respectively. They are so installed as to be read directly under the wing.

The scale indicates the fuel quantity in the unit of U.S. gallons. The indicator is graduated at intervals of 50 U.S. gallons. The indicator, designed to indicate the fuel level, consists of float, shaft, magnet and magnetic pointer.

The vertical movement of the float is converted into the rotation of the shaft. On the lower end of the shaft is installed the magnet. The magnetic field is changed by turning of this magnet. Following the changes in the magnetic field, the magnetic pointer rotates and indicates the fuel quantity.

The range of indication by this indicator is as follows.

Inboard side	75 to 425 U.S. Gal.
Outboard side	450 to full U.S. Gal.

5.7.2 Fuel Quantity Indicator Designed to indicate the Weight of Fuel

The indication system is of electrical capacitance type. The transmitter

submerged in the fuel generates and sends a signal to the indicator as electric capacitance varies with the change of fuel level.

Electric power for functioning is extracted from constant frequency main bus. The indicator is graduated in the unit of pound, at intervals of 100 lbs.

The three tank units are submerged in the tank as parallel circuits. The compensator which compensates the fuel quantity for variation of temperature is also submerged. These tank units and compensator as a transmitter sense the fuel quantity.

Measurement of Actual Quantity of Loaded Fuel

Gravimeter reading x 8,344 = Density (Lb/Gal.)

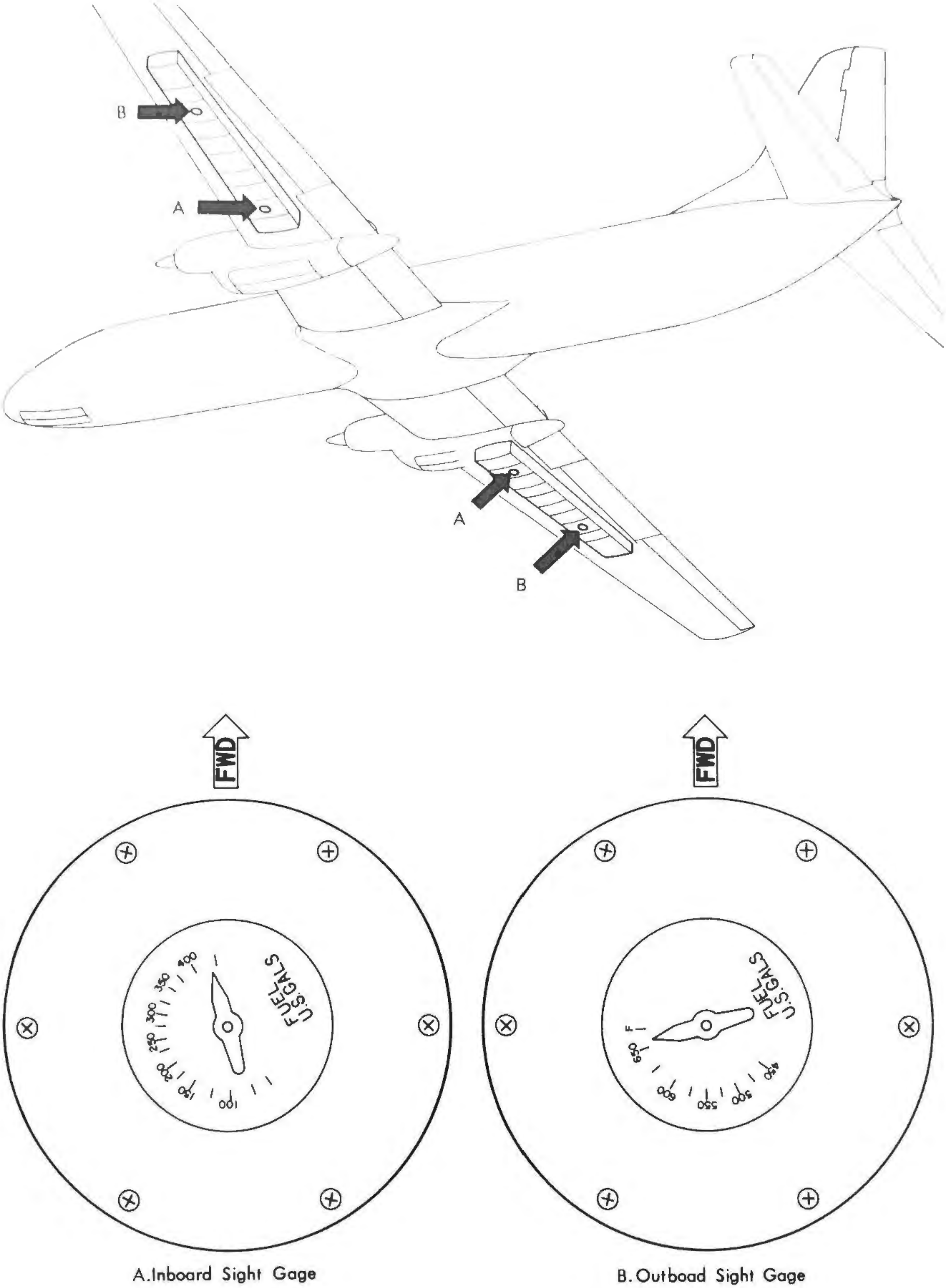
Major Components of the Indicating System is as follows:

(1) Indicator

(2) Tank Unit and Compensator

(3) Amplifier

NOTE: For the components of the indicating system, see Chapter 8, INSTRUMENT SYSTEM.



Fuel Tank Sight Gage Installation
Figure 5–33

5.8 Optional Equipment - Bag Tank

As the optional equipment of the fuel system, provisions for auxiliary tank installation are installed.

The aircraft is equipped with all necessary piping and wiring for auxiliary tanks. The dotted line part in Fig. 5-1 becomes effective only when auxiliary tanks are installed. When no auxiliary tanks are mounted, the piping is sealed with a blind cover at the inlet of the tank.

And, in place of a shut-off valve and a pressure switch in the line of the optional equipment, their dummies are installed. The wiring provision is blinded with plugs and not connected to the electric power source.

5.8.1 Auxiliary Tank

No. 2 and No. 3 tanks are bladder type bag tanks installed between wing spars inside the engine nacelle. The inner walls of the room enclosed by the wing spars are made from fabric reinforced plastic boards.

No. 2 tank consists of two cells while No. 3 tank of three cells. On the bottom and ceiling are installed interconnector fittings for the connection of cells, which are interconnected by pipes.

Bottom ....2-1/2 inch dia. pipe for fuel flow
Ceiling ....2-1/2 inch dia. pipe for tank vent

The tank is secured by button hangers to the side wall and by snap fasteners to the ceiling. Each inner wall has a guide.

The inter connectors of the tank is joined together with bolts with a tightening torque of 25 $\pm$ 5 inch-pounds.

5.8.2 Specifications of the Tank

	No. 2	No. 3
Total Capacity	909 ℓ	1,438 ℓ
Unusable Fuel Amount	7 ℓ	7 ℓ
Expansion Space	39 ℓ	78 ℓ

5.8.3 Fuel Refueling System

(1) Gravity Refueling

A filler cap for fuel refueling is installed on the upper surface of the wing at the tank location as alternative refueling means. Gravity refueling amount of fuel is as follows:

No. 2 Tank 870 ℓ (about 230 U.S. Gal.)
No. 3 Tank 1,360 ℓ (about 359 U.S. Gal.)

(2) Pressure Refueling

Pressure refueling provisions for bag tanks are common to integral tank pressure refueling provisions except that a shut-off valve in the line to the bag tank shall be opened for refueling.
Pressure refueling amount of fuel is as follows:

No. 2 Tank	820 ℓ	(about 217 U.S. Gal.)	50 U.S. Gal/min.
No. 3 Tank	1,320 ℓ	(about 349 U.S. Gal.)	50 U.S. Gal/min.

5.8.4 Fuel Feeding System (See Fig. 5-1)

(1) Transfer Line

One fuel transfer pump is mounted on one of the cells in each tank. Fuel in the bag tank is transferred as shown below.

No. 2 Tank ⟶ No. 1 Tank ⟶ No. 1 Engine
No. 3 Tank ⟶ No. 4 Tank ⟶ No. 2 Engine

In the transfer line is located the pressure switch which indicates the completion of fuel transfer from bag tanks to main tanks or the presence of any trouble in the transfer pump. In this case, the fuel empty warning light (Red) located at the shoulder of the fuel quantity indicator on the instrument panel in front of the copilot seat comes on.

Fuel transfer is performed by driving the transfer pump and controlled mechanically by the fuel level control valve in accordance with fuel level change in the integral tank. The fuel level control valve is installed in the integral tank at the extreme point of the fuel line from the bag tank to the integral tank, and functions automatically to stop fuel transfer when the fuel level in the integral tank reaches the full point and start fuel transfer when the fuel level drops.

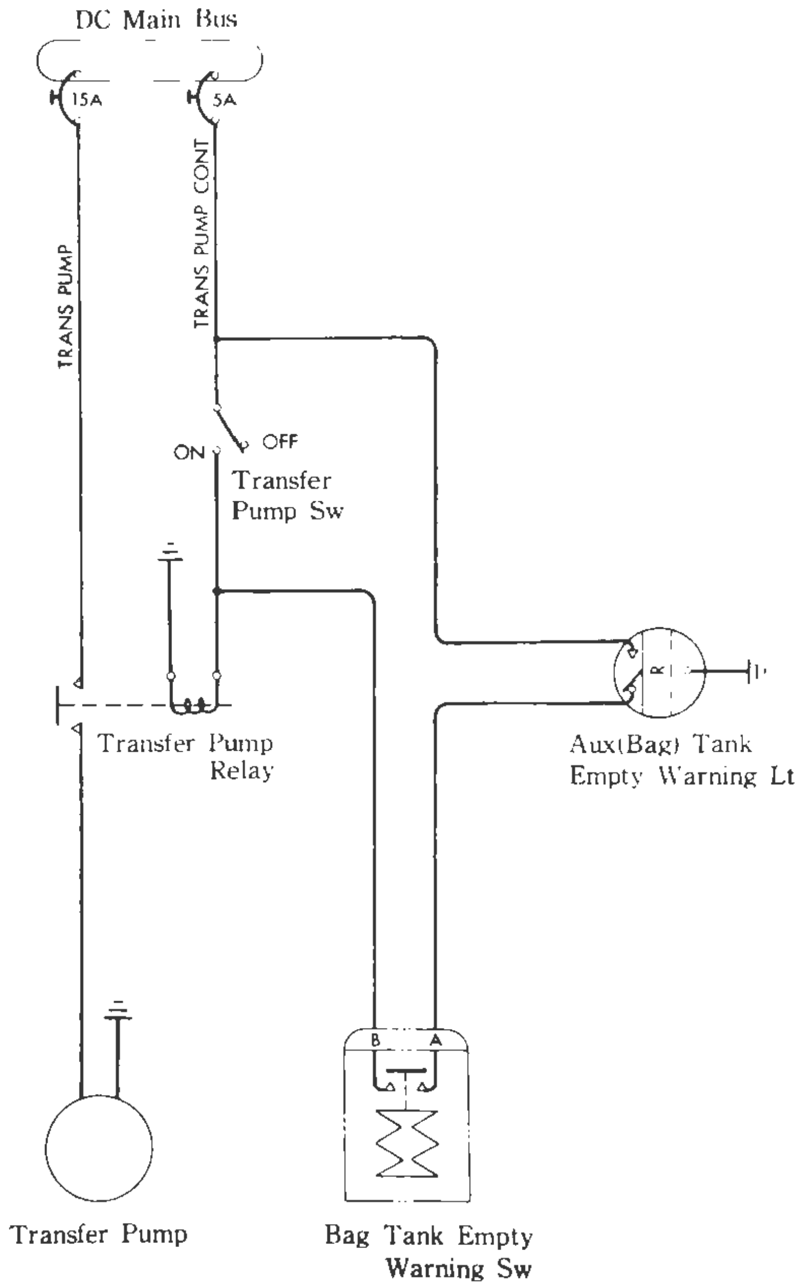
(2) Bag Tank Vent Line

The bag tank vent is led to the integral tank expansion space. The bag tank vent line running toward the wing tip behind the rear spar of the wing enters the integral tank passing through the rear spar at around W STA 9200 to vent the air inside. The bag tank is provided with an auxiliary vent line, which extends from the tank ceiling and joins the above-mentioned main vent line.

(3) Pipes

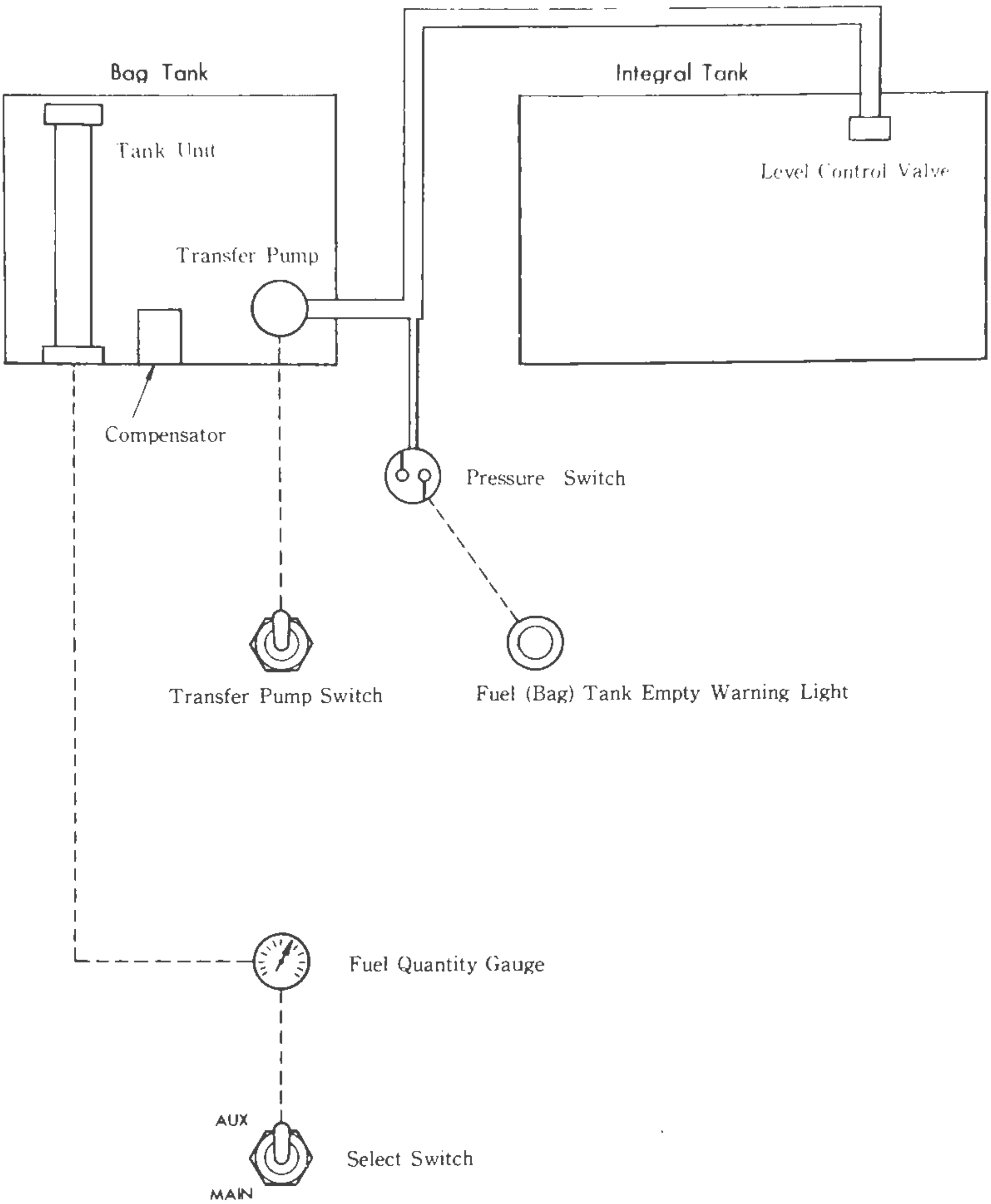
Sizes of the pipes used in the bag tank system are as follows.

Transfer Line	1 inch dia.
Vent Line	Main 1 inch dia. Aux 1/2 inch dia.
Pressure Refueling Line	1 inch dia.



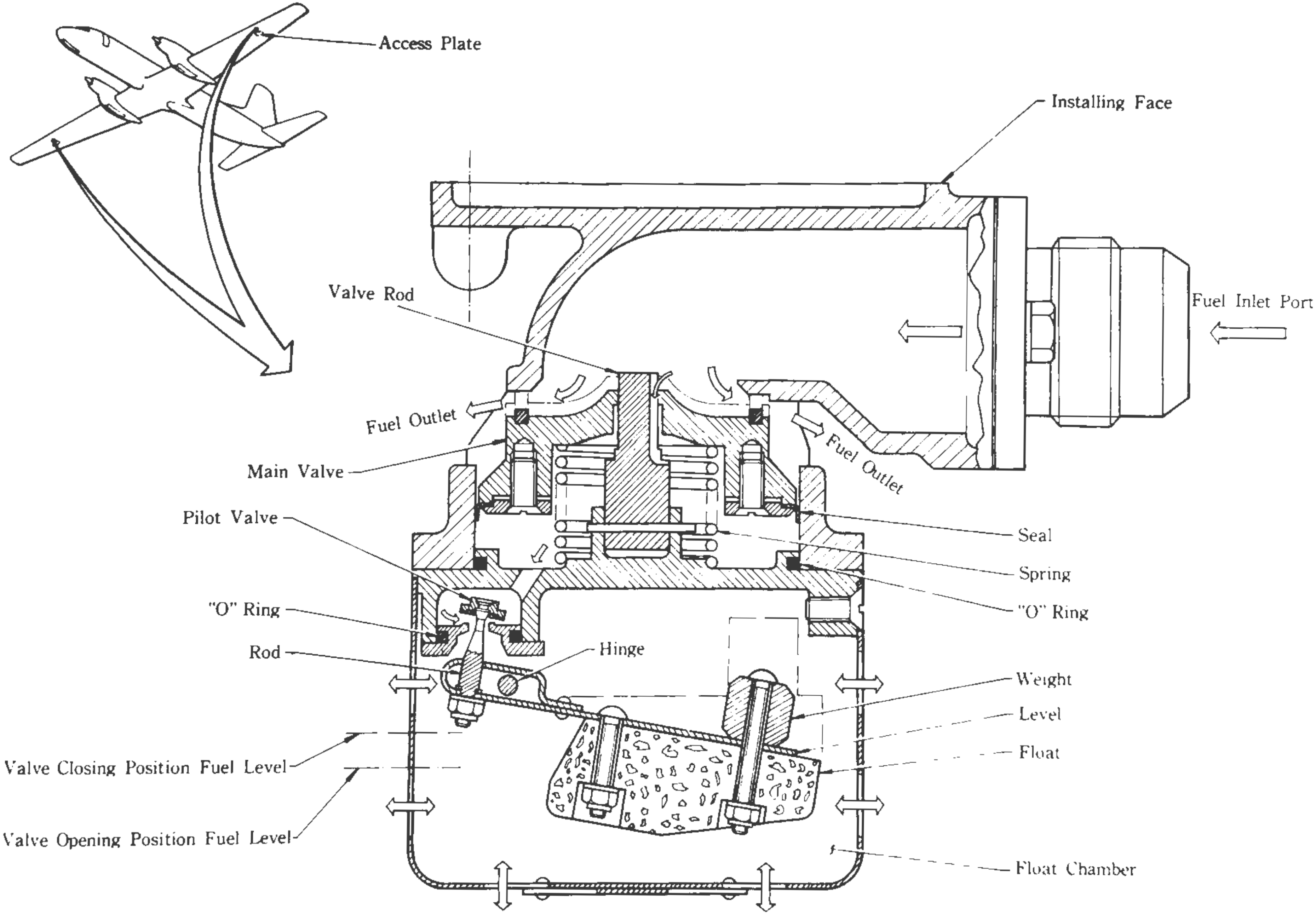
Fuel Transfer System Theoretical Diagram

Figure 5-33A



Fuel Bag Tank System

Figure 5-33B



Level Control Valve Section View
Figure 5-33C

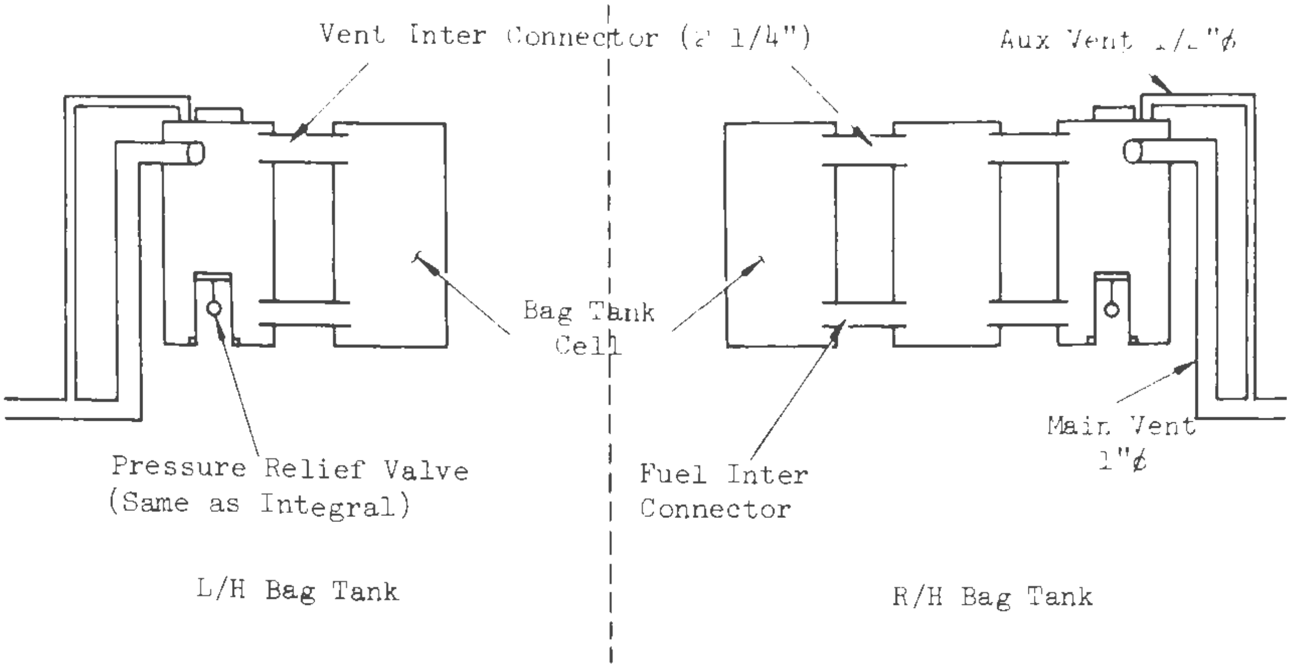

Vent Inter Connector (2 1/4")
Aux Vent 1/2"ø
Bag Tank
Cell
Pressure Relief Valve
(Same as Integral)
Fuel Inter
Connector
Main Vent
1"ø
L/H Bag Tank
R/H Bag Tank

Figure 5-33D

5.8.5 Bag Tank Accessories

Fuel transfer pump installed on the mount at the bottom of the cell. The fuel quantity indicating transmitter and compensator, and float switch for pressure refueling comprise the bag tank accessories. The pressure relief valve is installed in the outside bag tank.

Construction and functions of above-mentioned accessories are the same as those mentioned already and explanation on these accessories is omitted here.

5.8.6 Fuel Quantity Indicator

The fuel quantity indicator in the cockpit, used in common for both integral and bag tanks, is designed to be selected by means of the selector switch. However, when bag tanks are not equipped, the following units are not provided and their connections are blinded.

(1) Selector Switch

(2) Tank Empty Warning Light

(3) Transfer Pump Switch

5.9 <u>Water/Methanol System</u>

5.9.1 General Description (See Fig. 5-35)

Engine output varies with atmospheric temperature. The water/methanol system of this aircraft is designed to inject water-methanol into the first stage impeller of the engine compressor to keep the maximum engine power 3,060 HP necessary for take-off by lowering the temperature and increasing the density of intake air as long as the outside air temperature variation remains within the range from -20°C to I.S.A. + 30°C.

Water/methanol delivered under pressure from the tank by means of the booster pump is metered to the desired quantity by the engine water/methanol metering unit.

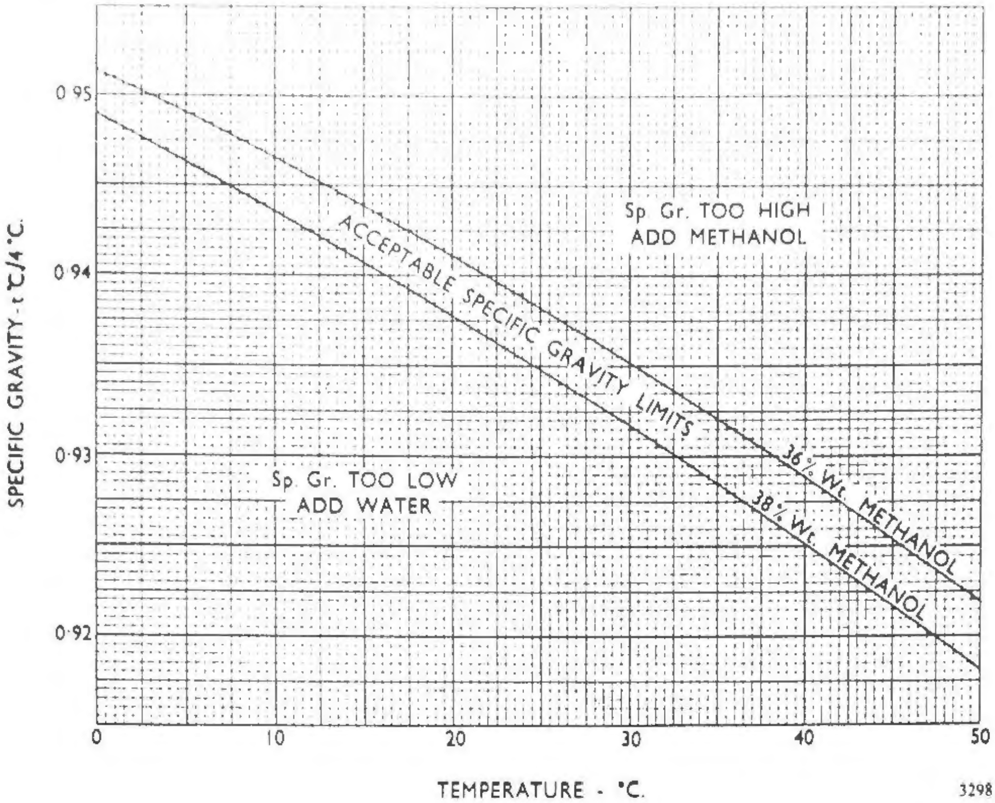
<u>NOTE</u>: As to the engine water/methanol metering unit and the water/methanol control unit, see Chapter 4, POWER PLANT.

5.9.2 Water/Methanol Tank (See Figs. 5-36, 5-37 and 5-38)

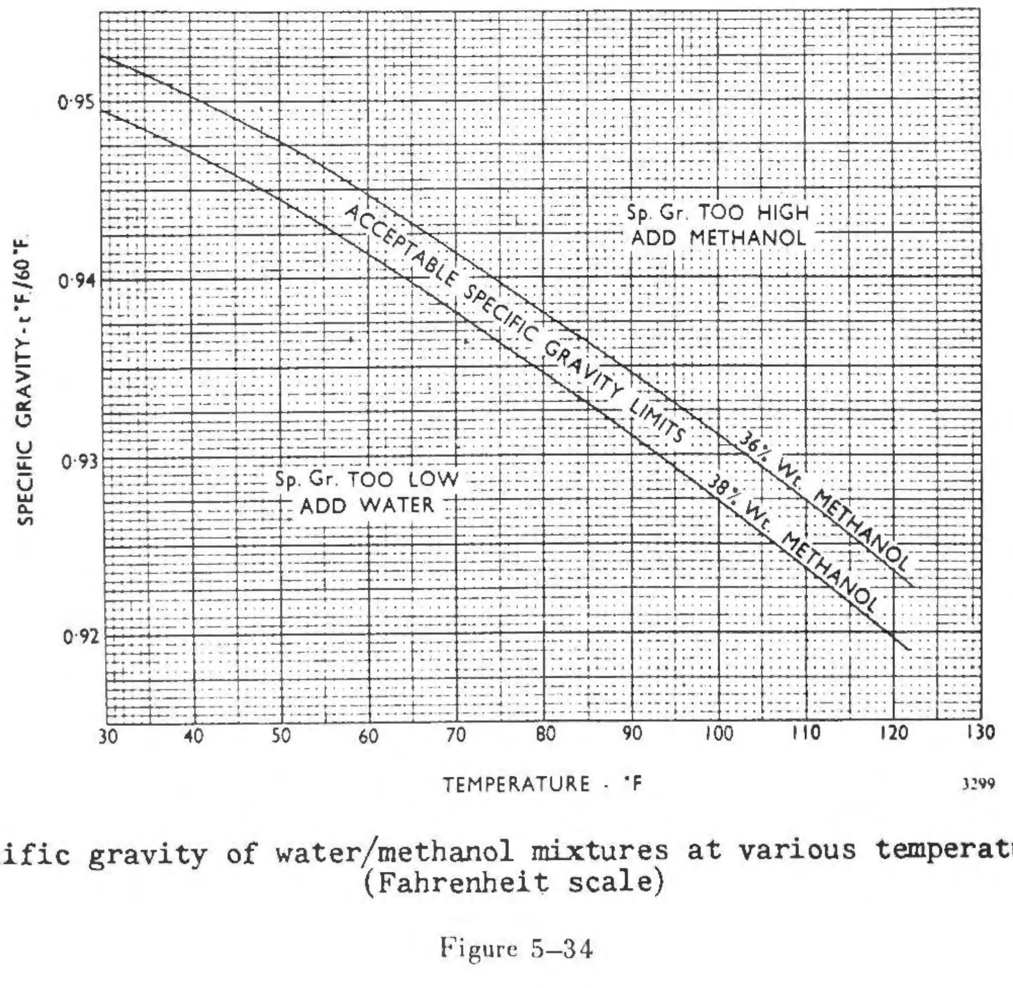
A synthetic rubber bladder type tank is installed in a cavity between the front and rear spars of the left outer wing, from W. STA 400 to W. STA 1,100.

The tank is fastened in the cavity by snap fasteners to the ceiling and by button fasteners to the side wall.

On the top of the tank is installed the filling port and at the bottom of the tank is installed the mount for pump installation. The main line and auxiliary vent line are attached to the tank.

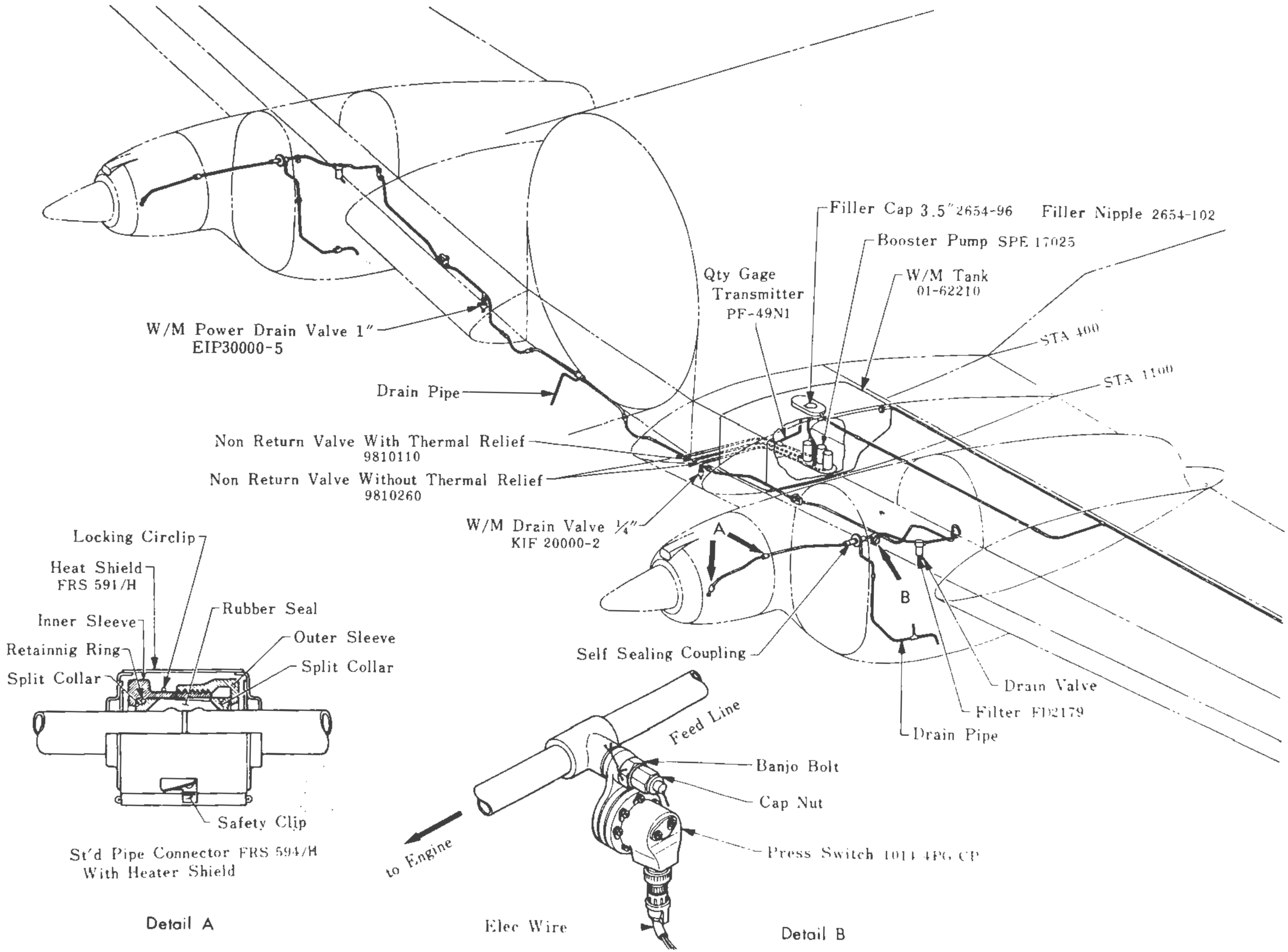


Specific gravity of water/methanol mixtures at various temperatures
(Centigrade scale)

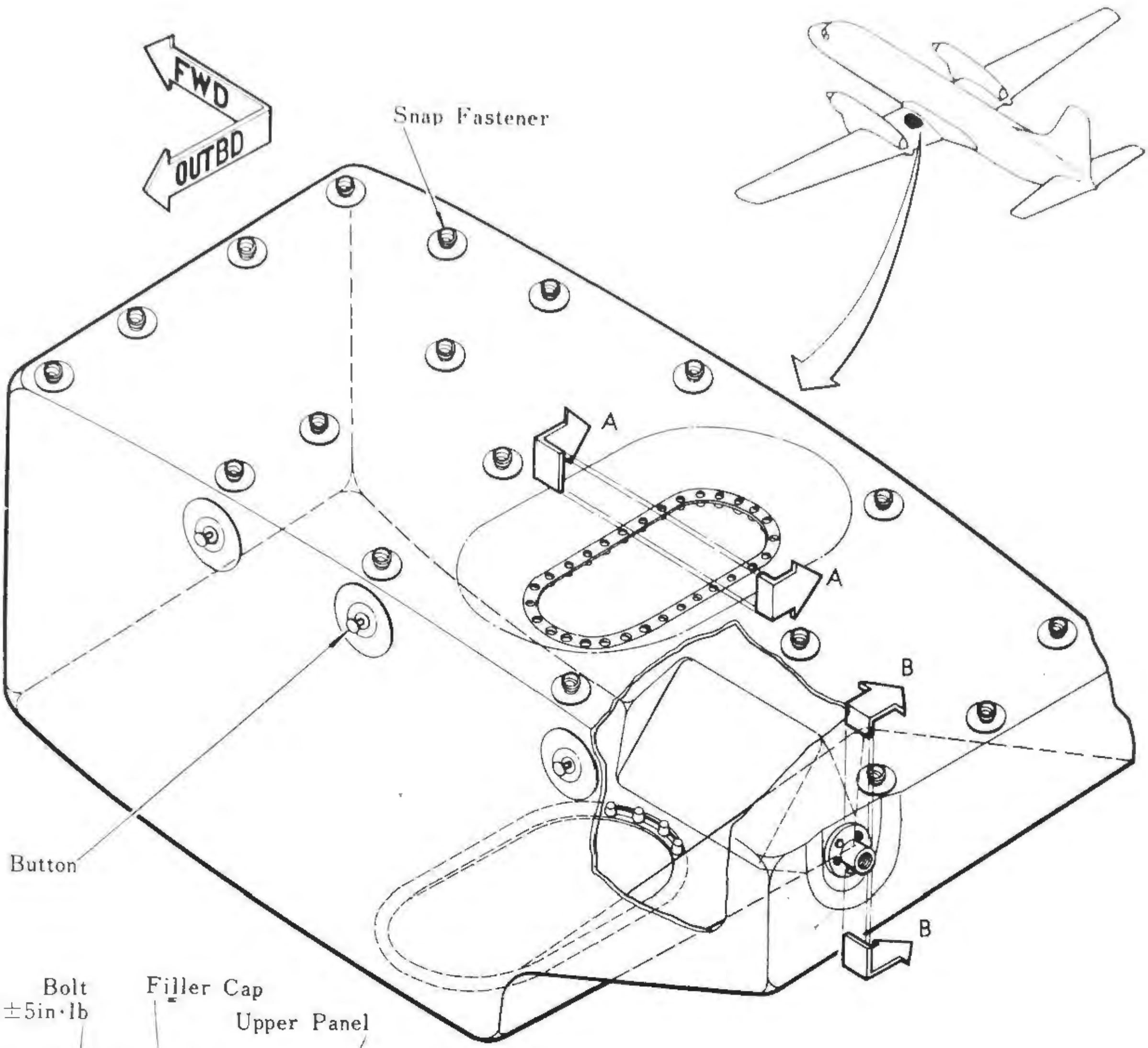


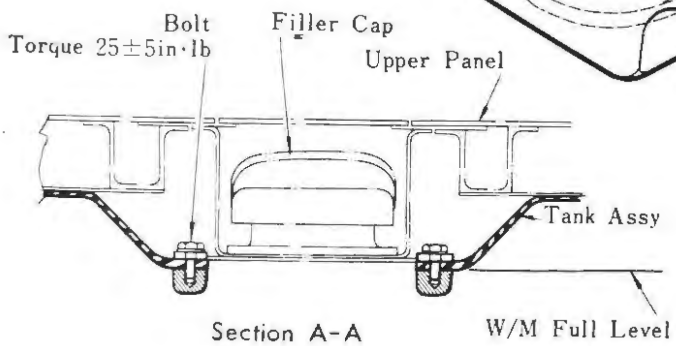
Specific gravity of water/methanol mixtures at various temperatures
(Fahrenheit scale)

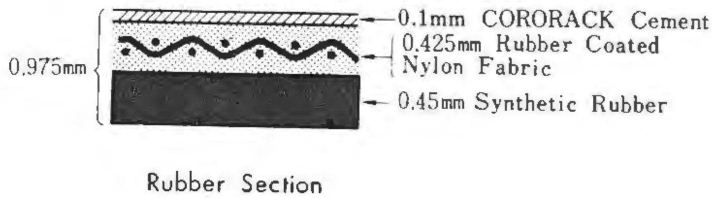
Figure 5–34

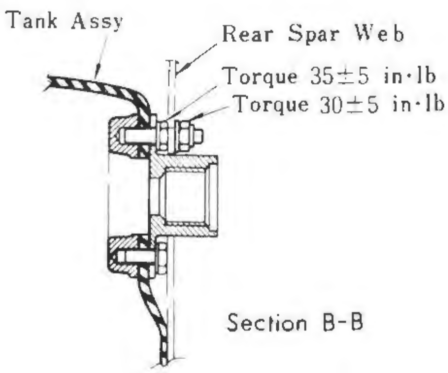


W/M System General Arrangement
Figure 5–35







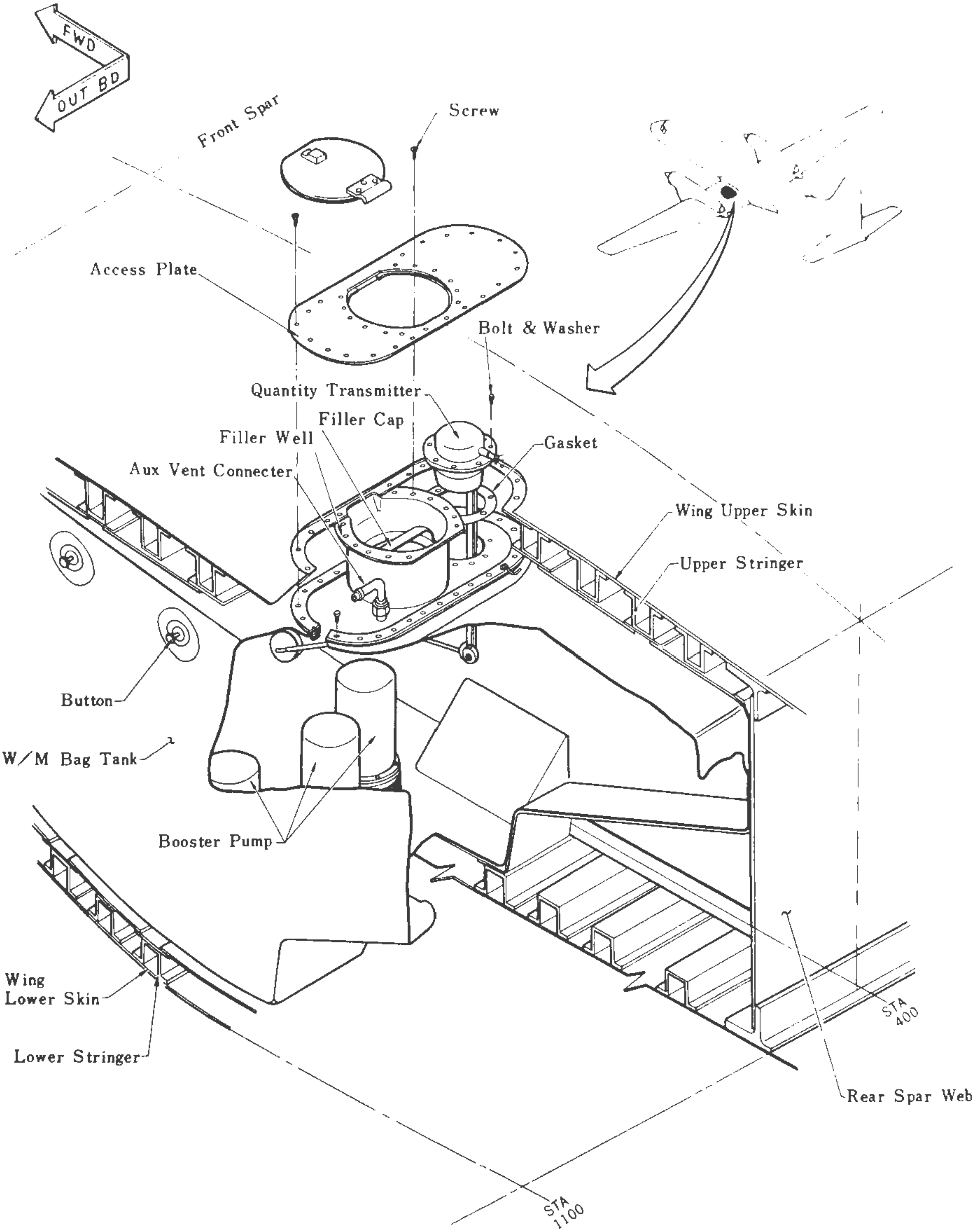


Note :

1. May be used the tank if no leakage at 0.5psi
2. Not use the bolt that is not shown on the drawing

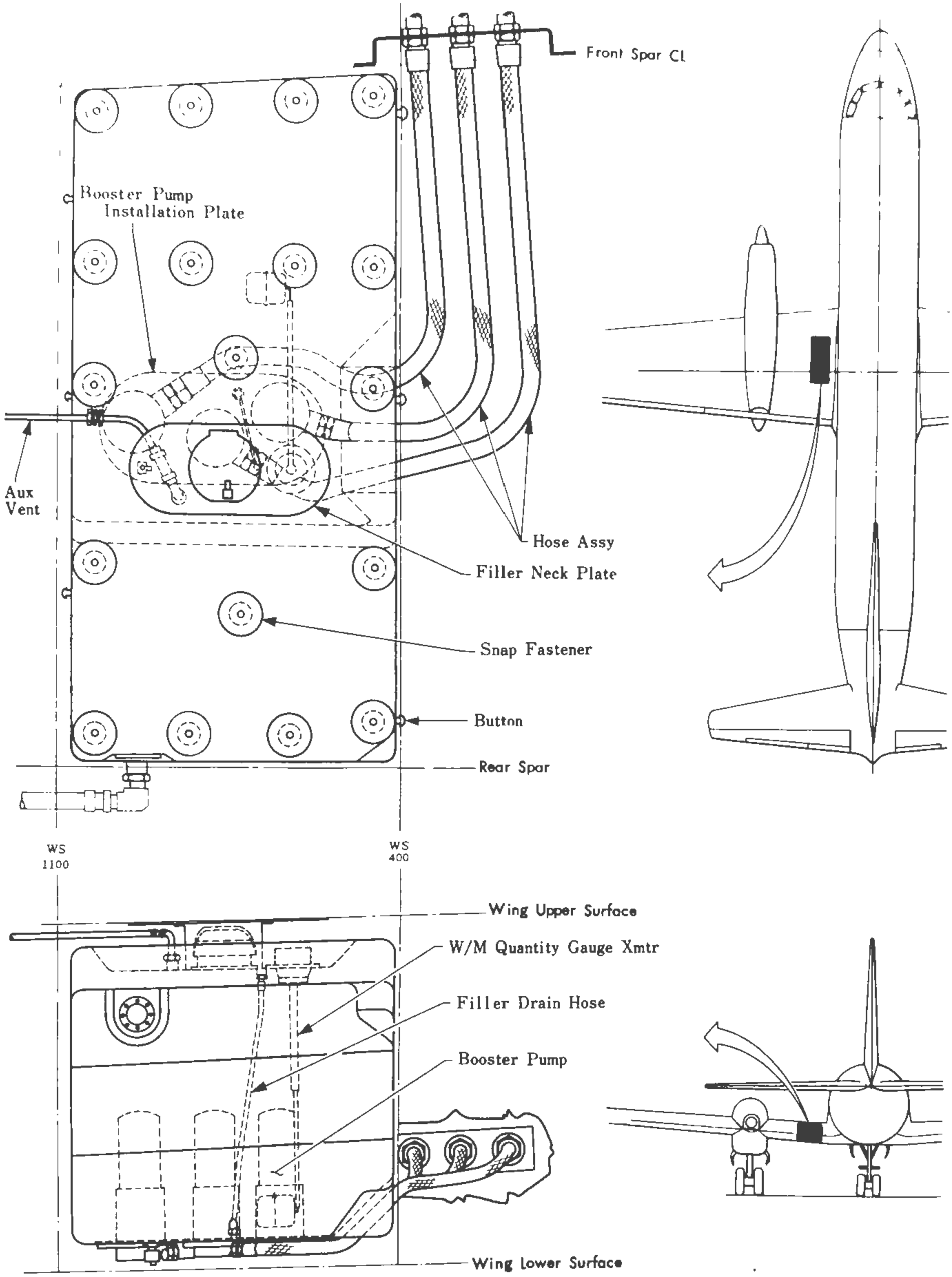
W/M Tank

Figure 5-36



Installation of W/M Tank Equipments

Figure 5–37



W/M Tank Installation (Locking from Upper and Aft)

Figure 5-38

Replenishment of water/methanol is accomplished through the filling port on the upper surface of the wing. (Maximum Capacity 111 U.S. Gal.)

5.9.3 Specifications of Water/Methanol

Specifications for the water/methanol conform to Rolls-Royce Specification for AEP-1-W/M, ISSUE 5, AMENDMENT 2.

British Standard 506 : 1958
American Federal Specification O-M-232d (Grade 4)

As for the mixing ratio, methanol and water are mixed in weight ratio as follows:

Methanol	CH_3OH	37 ± 1%
Water	H_2O	63 ± 1%

5.7.4 Water/Methanol Sub-system

(1) Water/Methanol Feed System (See Figs. 5-39, 5-40 and 5-41)

Three submerged type booster pumps are installed at the bottom of the tank for delivery of water/methanol to both right and left engines under pressure.
Water/methanol boosted by and delivered from the booster pump passes through the non-return valve and comes into the collector pipe located in front of the wing front spar, from which water/methanol flows to either engine through the feed line. A shut-off valve, filter and pressure switch are installed in this feed line. The feed line is a 1 inch diameter stainless steel pipe.

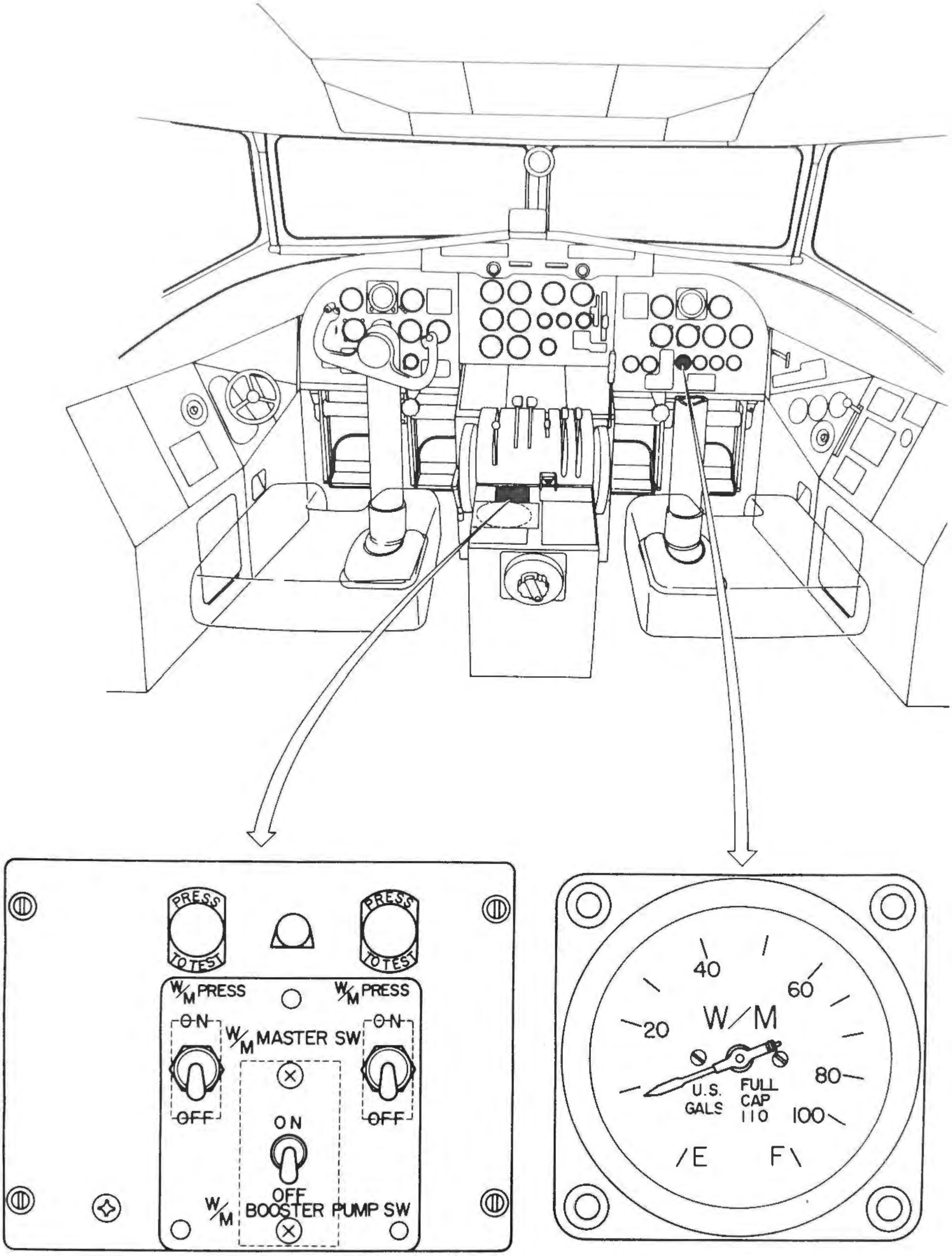
Operation of Feed System

At the center pedestal in the cockpit, the water/methanol control panel is located. Turn the water/methanol booster pump switch "ON," then the three booster pumps start to operate simultaneously. Advance the H.P. cock lever to the fuel "ON" position or further and turn the master switch "ON," then the shut-off valve is opened, allowing water/methanol to flow to the engine metering unit.

When line pressure exceeds 14 ± 0.4 psi, the pressure switch closes its contact point and the indicating light (green) on the control panel comes on.

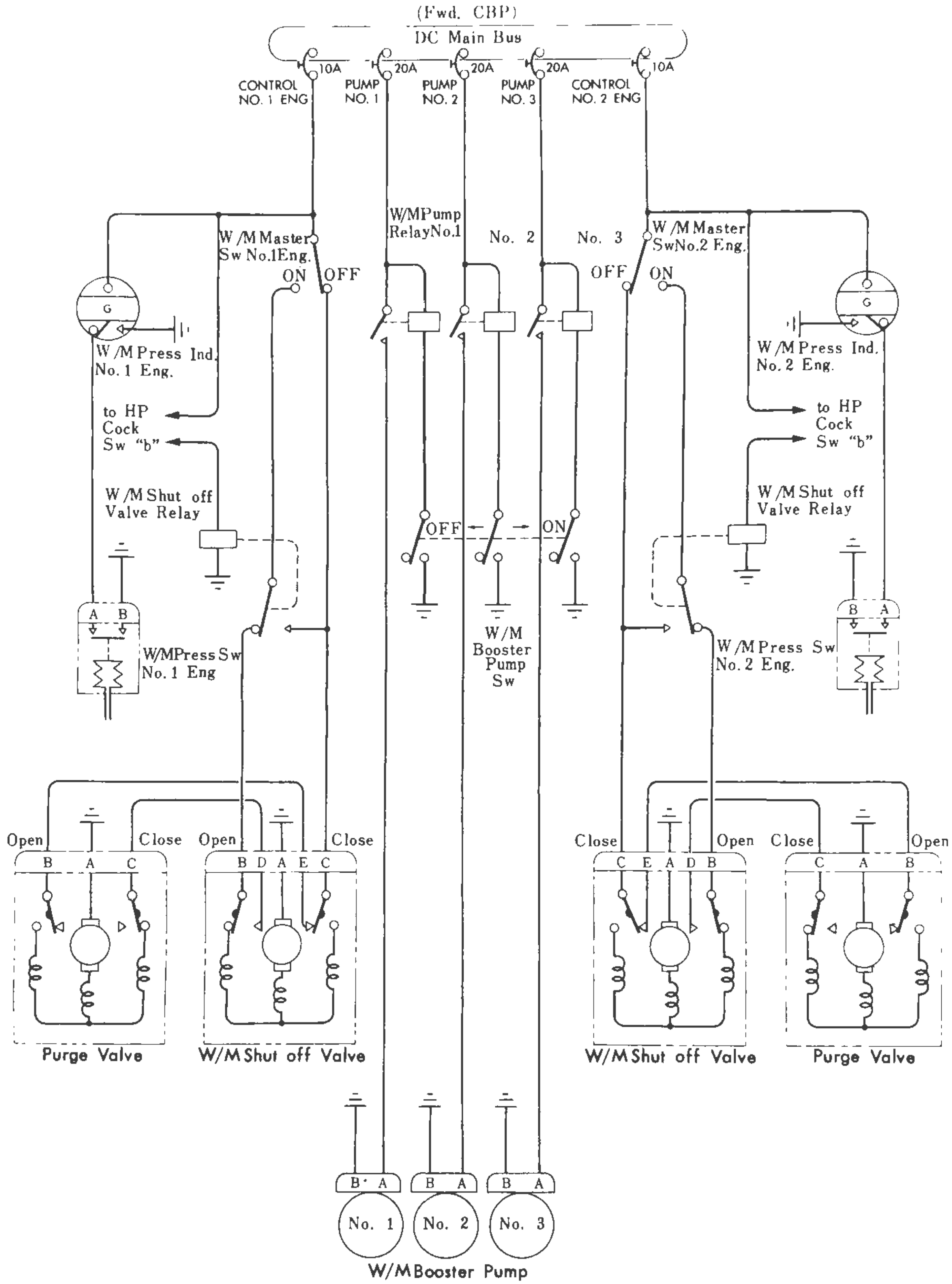
Water/methanol which reached the engine metering unit is not injected into the engine until engine speed has exceeded 14,800 r.p.m. as the unit is connected to and controlled by the engine throttle lever by means of the linkage.

An auxiliary vent line is connected to the main vent line on the way, and the vent outlet is opened in the vicinity of W. STA 9,300 near the fuel vent outlet.



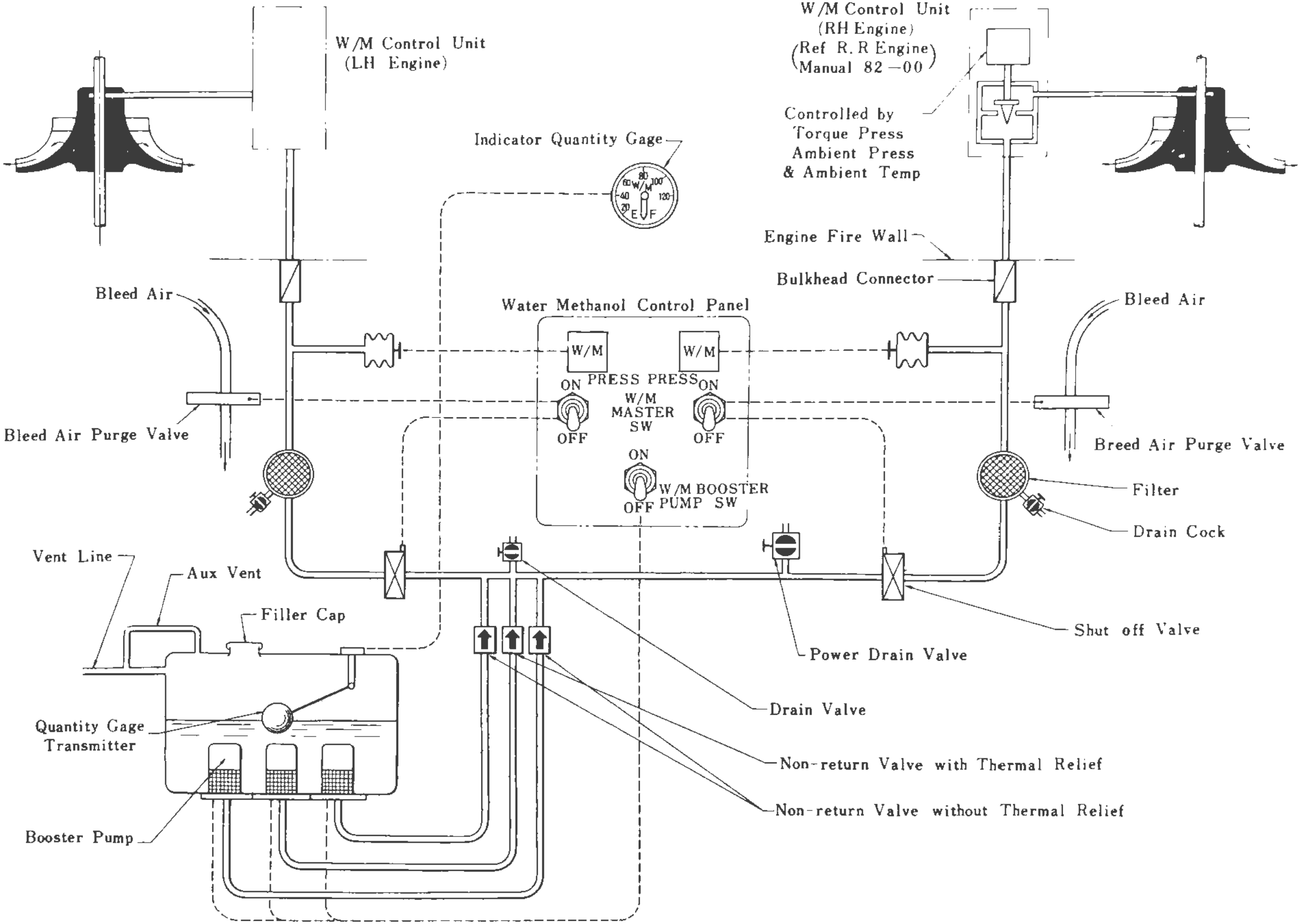
W/M Control Panel and Indicator

Figure 5–39



W/M Theoretical Diagram

Figure 5–40



W/M System Control Diagram
Figure 5-41

5.9.5 Engine Bleed Air Purge System (See Figs. 5-41 and 5-42)

Engine bleed air is bled from the second stage compressor outlet. The bleed air is utilized as sub-power source of the pressure control unit of the air conditioning system. If water/methanol is injected into the first stage compressor, the air containing water/methanol is fed to those units which may be corroded by water/methanol.

Therefore, when injecting water/methanol, it is necessary to prevent the bleed air from entering into the units and discharge the water/methanol left in the piping outboard so that the non-contaminated air may be fed to the air conditioning system. For this purpose, the purge valve is installed in the engine bleed air line. This purge valve is electrically connected to the feed line shut-off valve.

When the master switch is turned to "ON"

1. Shut-off Valve ⟶ Open

   then,

2. Purge Valve ⟶ Close

Thus the airframe can be protected from water/methanol containing vapor whenever water/methanol is injected into the engine.

When the master switch turned "OFF"

1. Shut-off Valve ⟶ Closed

   then,

2. Purge Valve ⟶ Open

When the purge valve is in the way to open position, the valve is opened to the intermediate purge position. Therefore the water-methanol containing vapor left in the line between compressor outlet and the purge valve is discharged outboard and the clean air is supplied to the air conditioning system control equipment.

5.9.6 Construction of Sub-system

(1) Booster Pump (See Figs. 5-43 and 5-44)

The water/methanol booster pump and the 28V D.C. driven motor of anti-explosion construction are assembled into an integral unit. A radio noise filter and a pump drain hole are provided at the bottom of the pump proper. On the side of the pump are provided an water/methanol outlet, electric contactor and gland drain fitting.

(2) Non-Return Valve (See Fig. 5-45)

The non-return valve is of the same construction as that used in the fuel system.

(3) Shut-off Valve (See Fig. 5-46)

The shut-off valve is a gate valve driven by a 28 volt D.C. motor. The motor and the valve are joined by bolts into one unit. Valve operating time is 2 to 3 seconds.

An indicator is provided to ascertain the operating position of the valve from the outside. The valve has a built-in relief valve (OPEN at 1 psi) to relieve the line pressure.

(4) Coupling (See Fig. 5-47)

The couplings used for piping in general are wiggings flexible couplings and F.R.S. connectors.
These couplings used inside the nacelle are covered with stainless steel shrouds. At the fire wall, quick disconnect couplings are employed to accomplish effective engine change work.

(5) Filter (See Fig. 5-48)

The filter is designed to trap up to 20 micron foreign objects. It has no by-pass valve inside. At the bottom of the filter, the drain valve is installed.

5.9.7 Indicator (See Figs. 5-49 and 5-50)

The water/methanol indicating system consists of the following two.

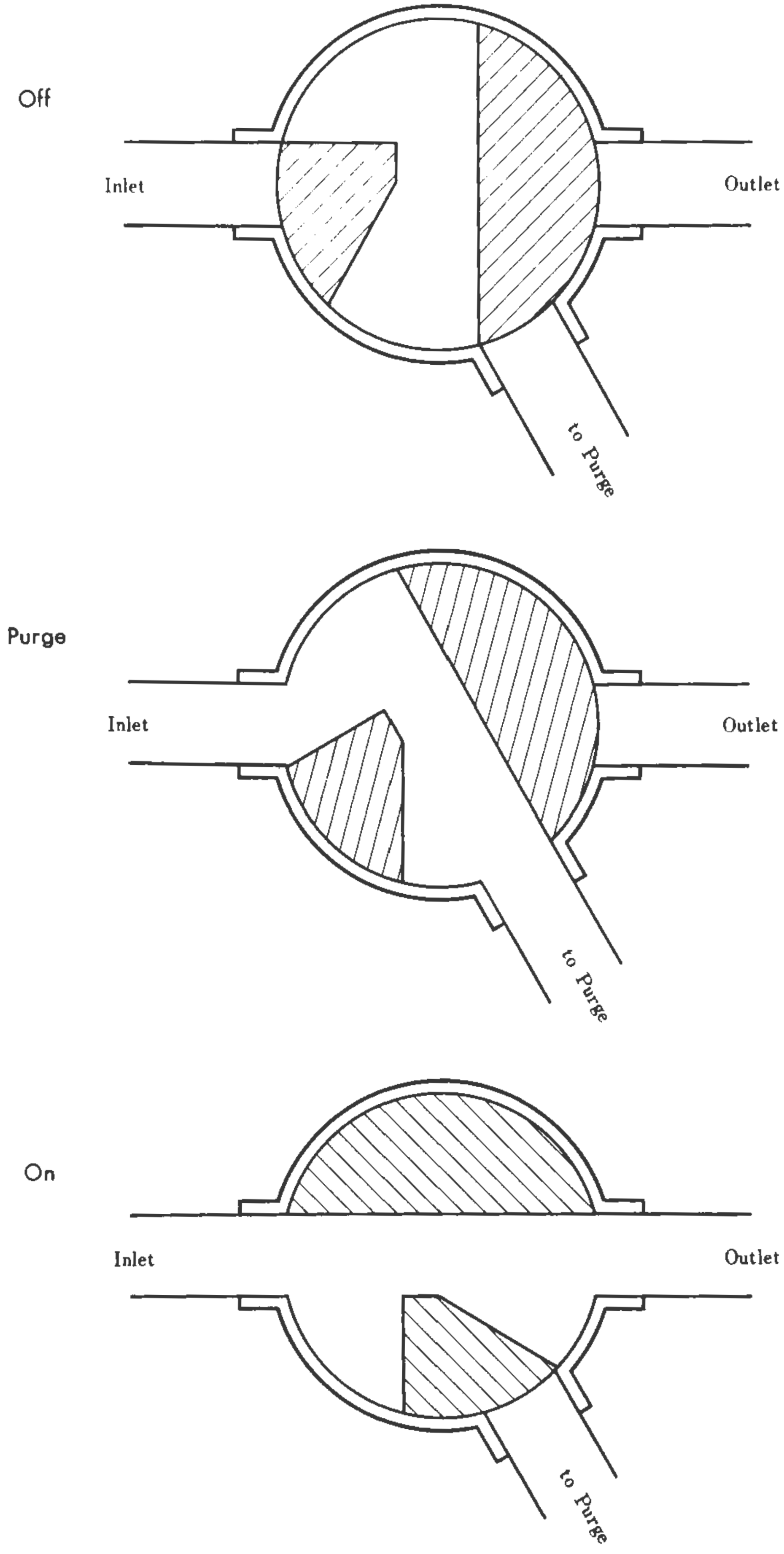
(1) Water/Methanol Quantity Indicator

The motion of the transmitter, suspended from the ceiling in the tank, corresponding to the height of the liquid level is converted into a change in electric resistance to indicate the quantity.

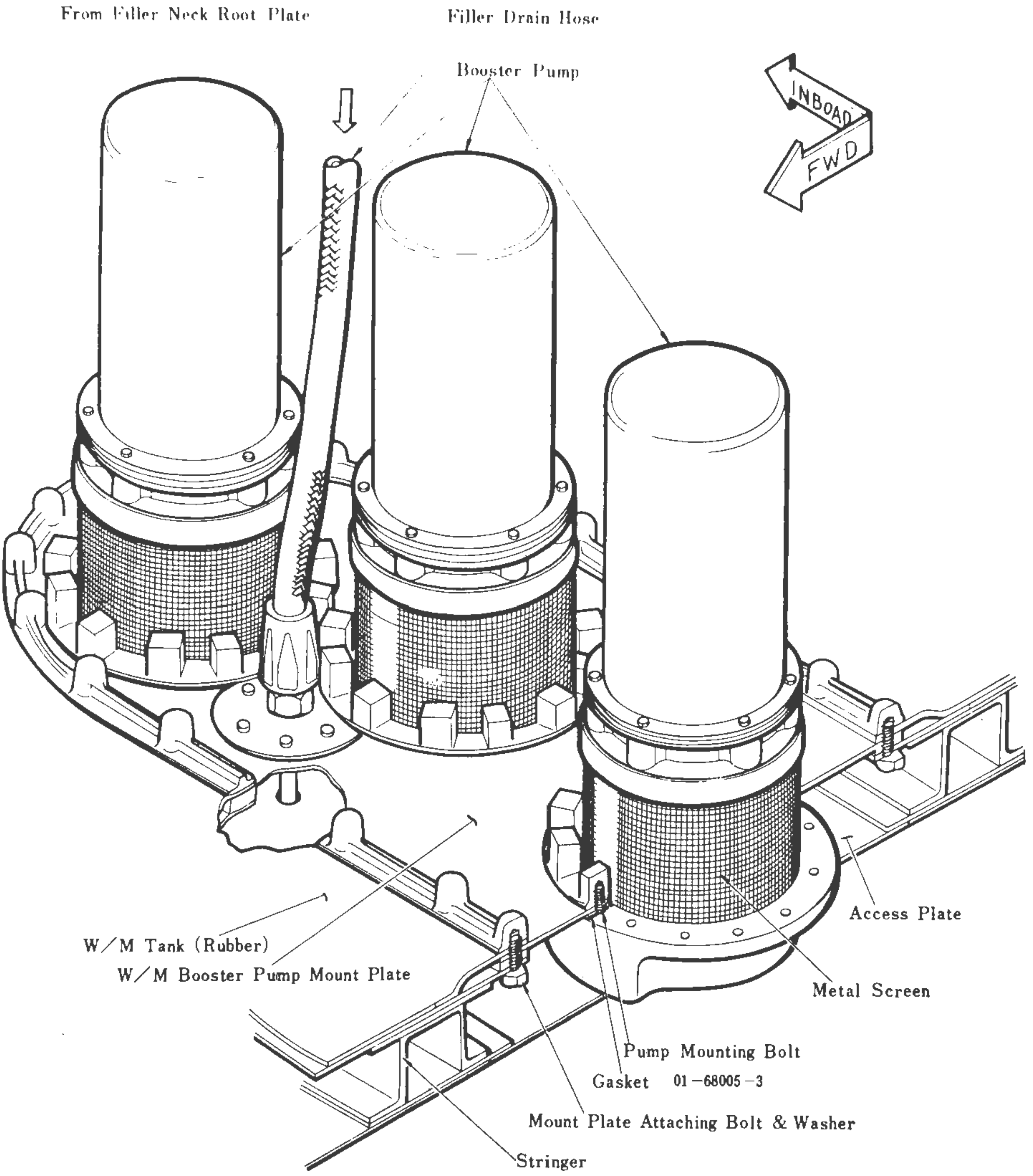
Indication is given in U.S. gallons. The scale is graduated from Empty (0 U.S. Gal.) to Full (111 U.S. gal.) at unequal angles within the indicating range of 300 degrees.

(2) Water/Methanol Pressure Indicator

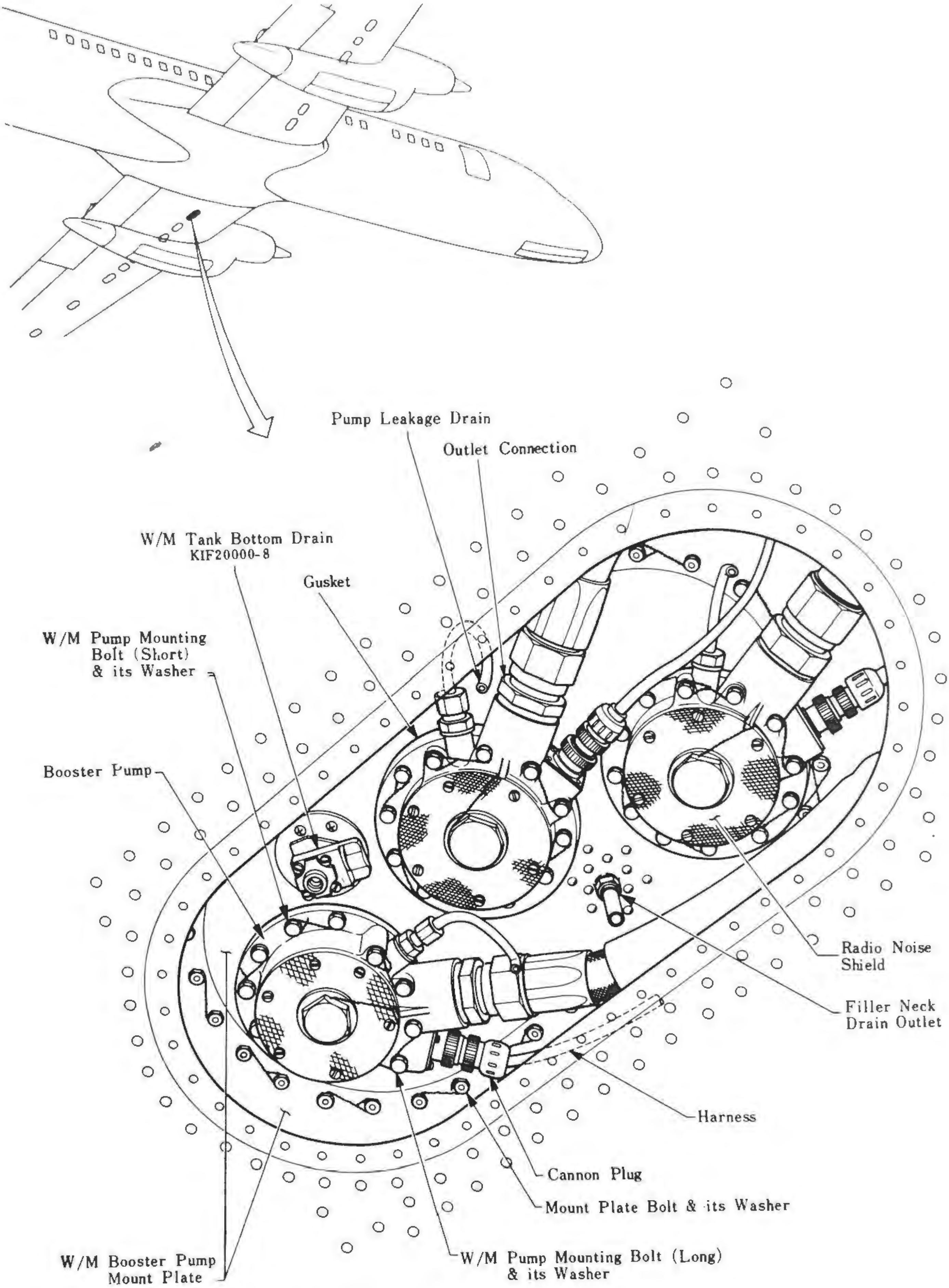
The indicating system indicates the pressure of the water/methanol being supplied to the engine at the time of water/methanol injection. When the pressure of water/methanol exceeds the prescribed value, 14 $\pm$ 0.4 psi, the indicating light (green) comes on.



Purge Valve Position
Figure 5–42

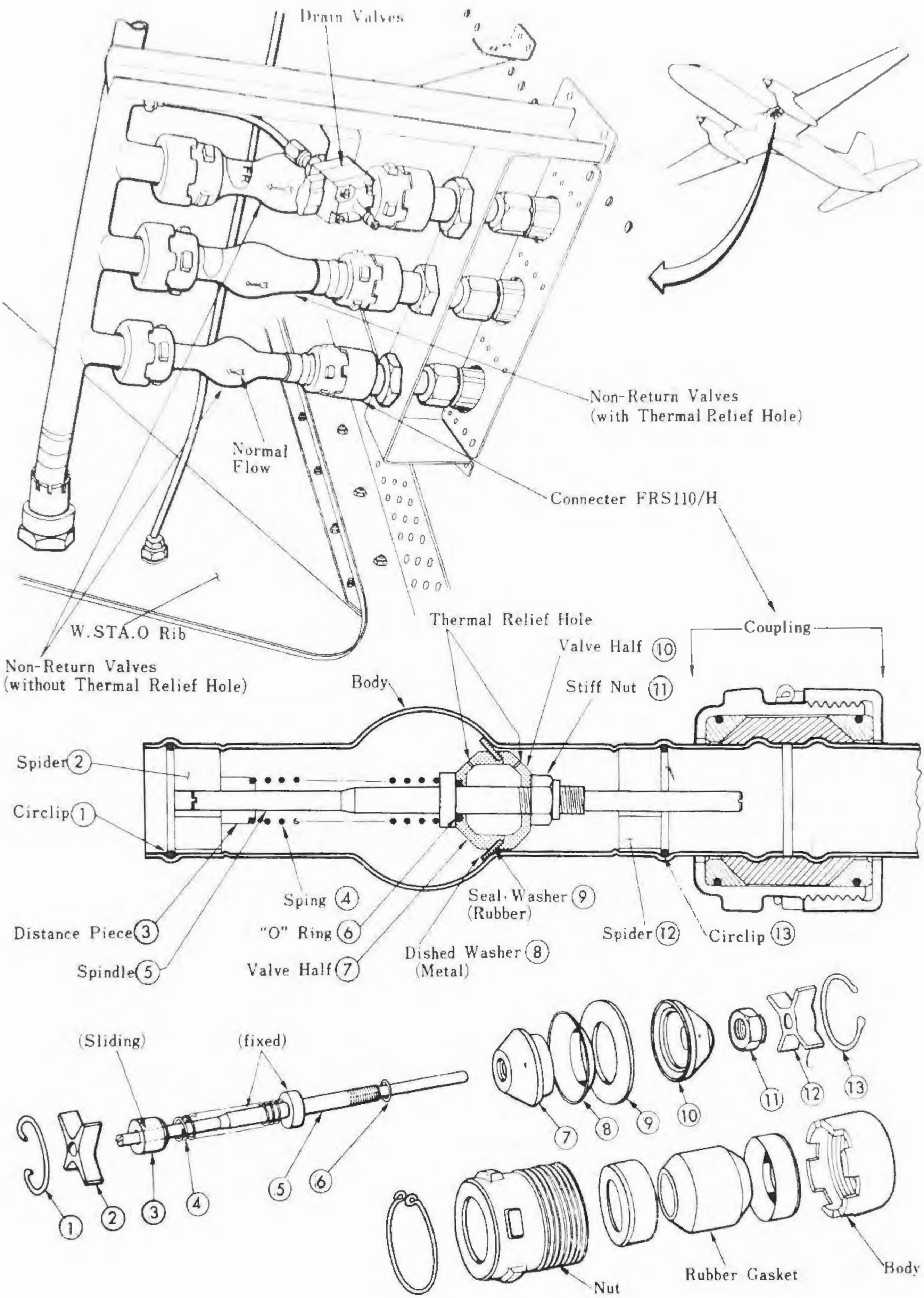


W/M Booster Pump Installation
Figure 5-43



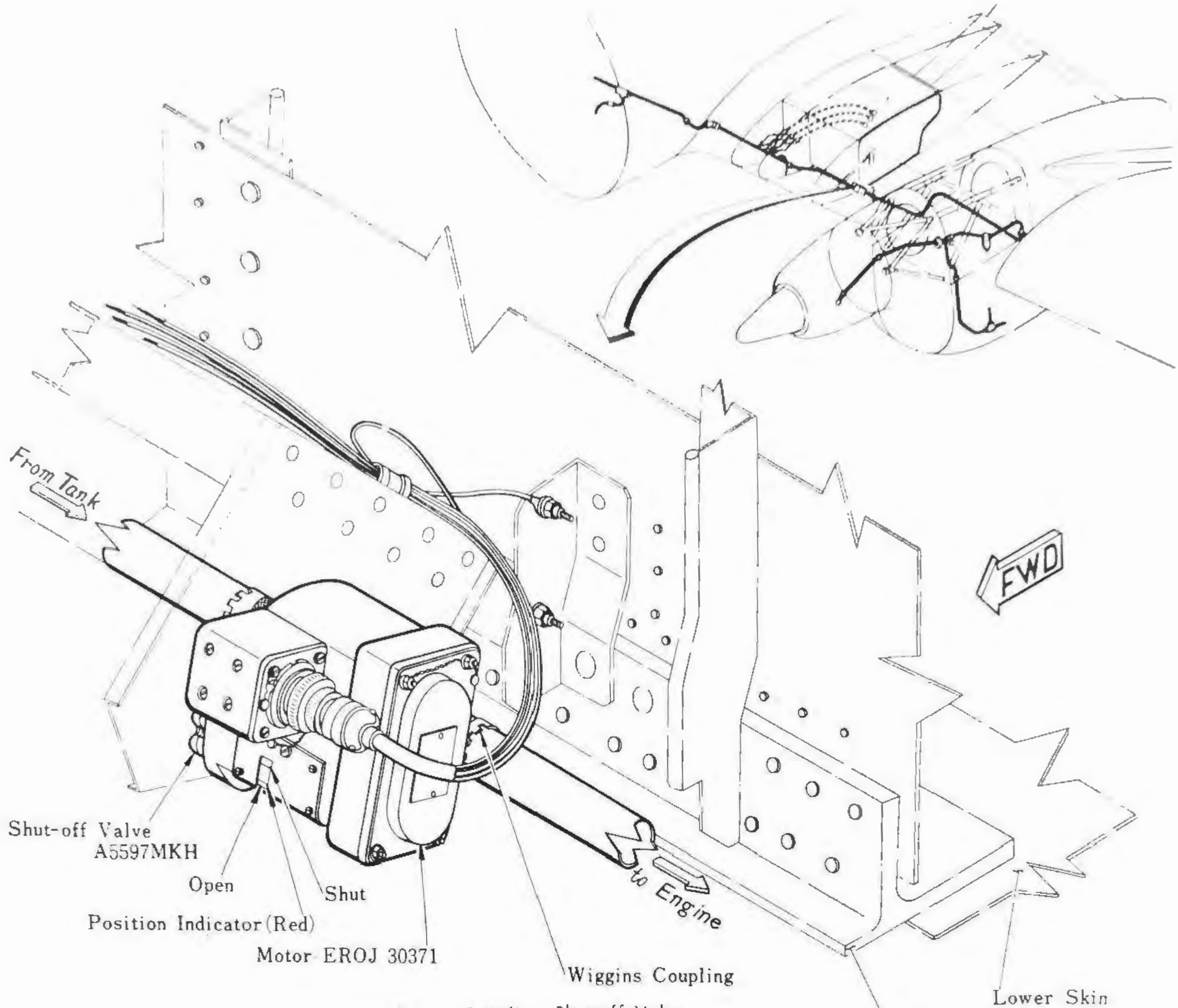
W/M Booster Pump Installation (Looking from Ground)

Figure 5–44

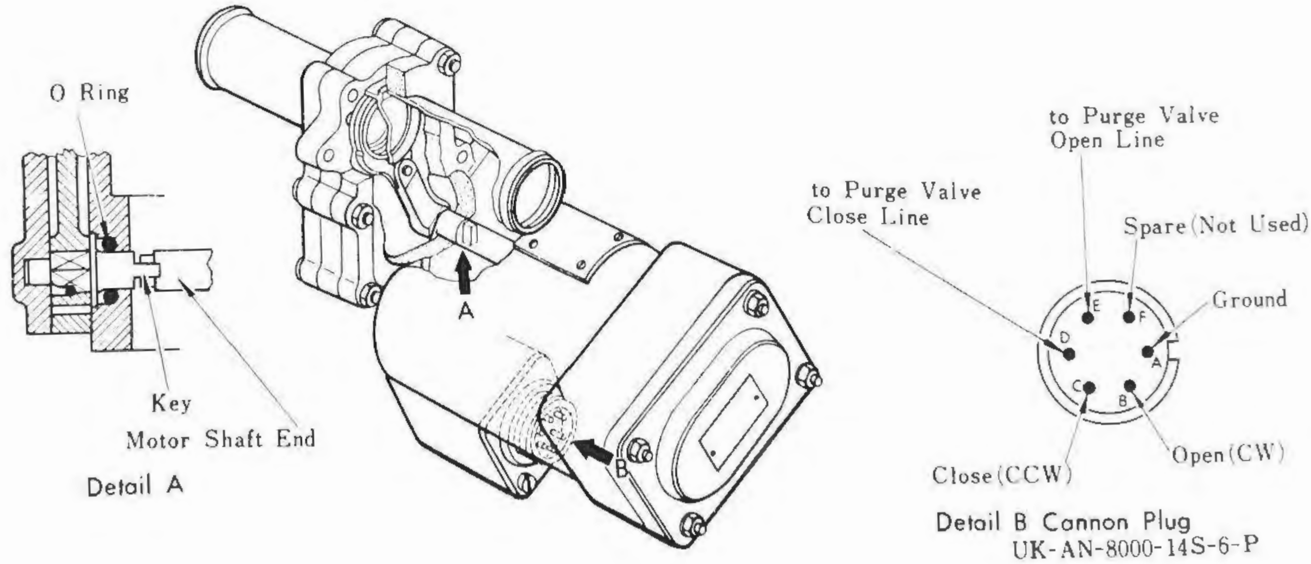


W/M Non-Return Valves

Figure 5—45



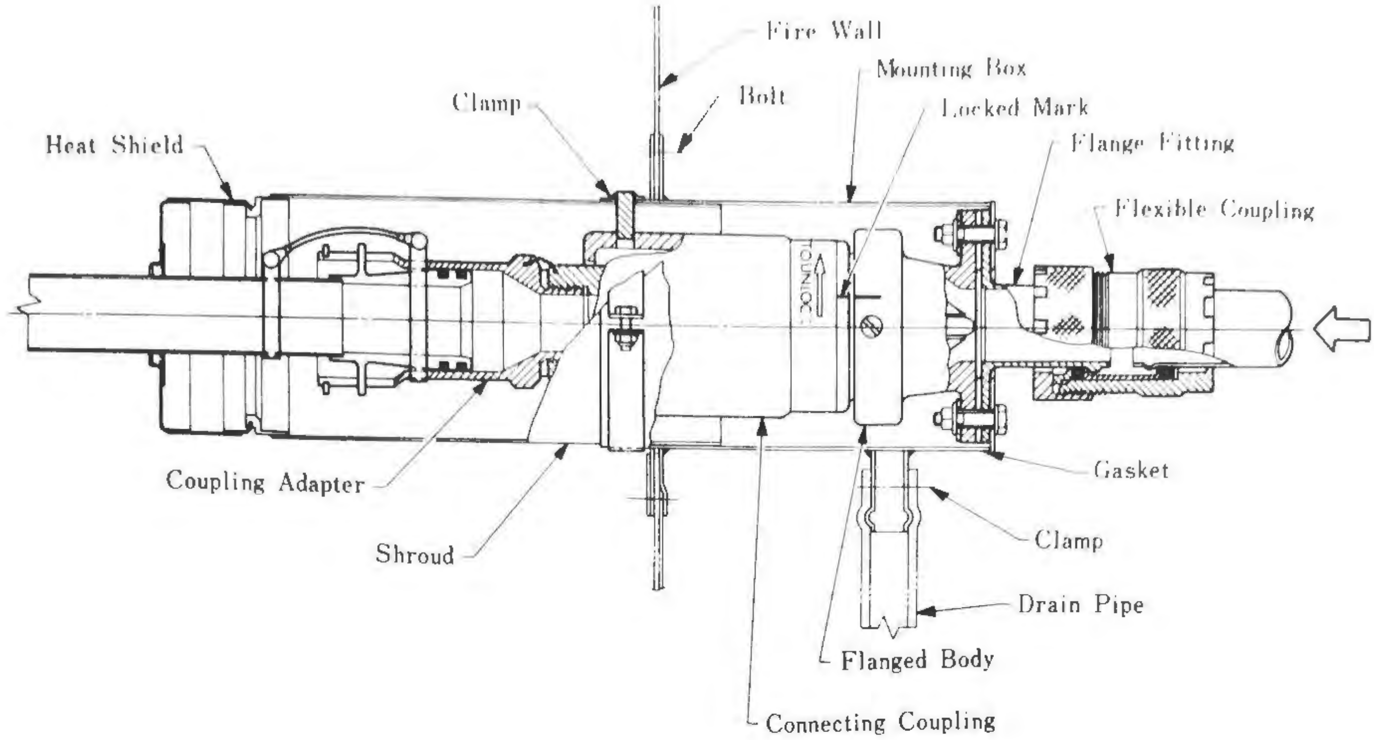
Installation of W/M Shut-off Valve

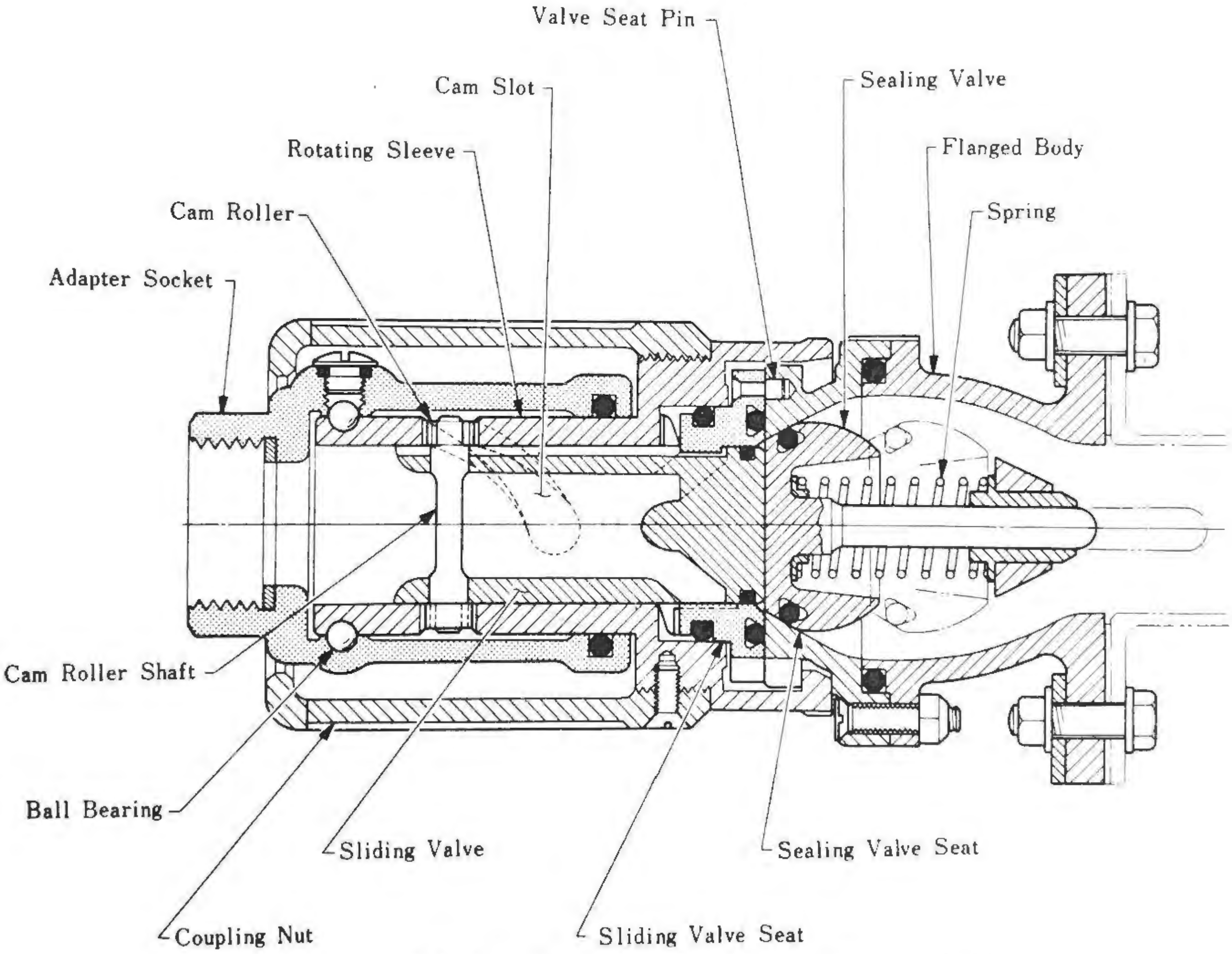


Detail A

Detail B Cannon Plug
UK-AN-8000-14S-6-P

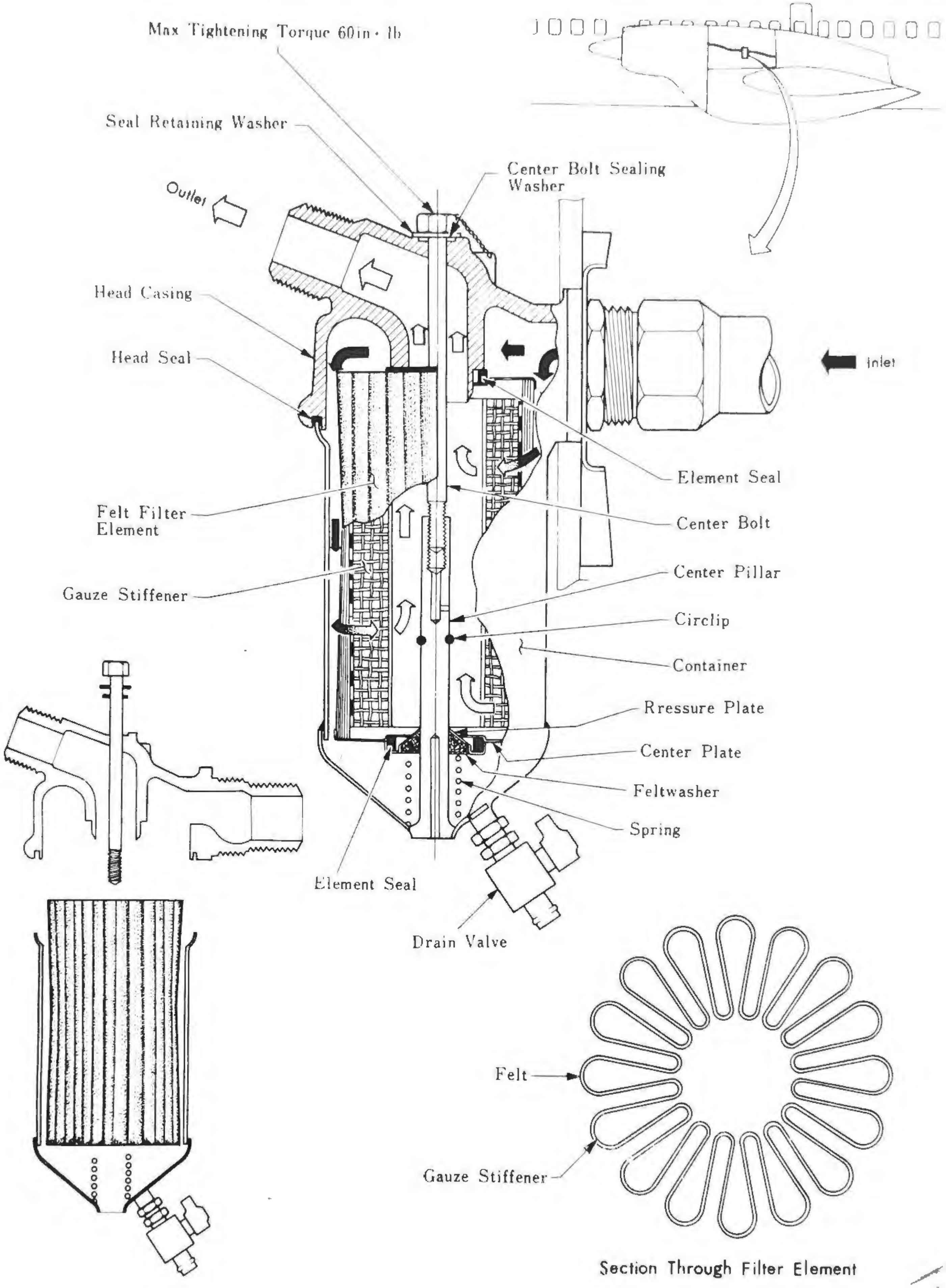
W/M Shut off Valve Assembly
Figure 5–46



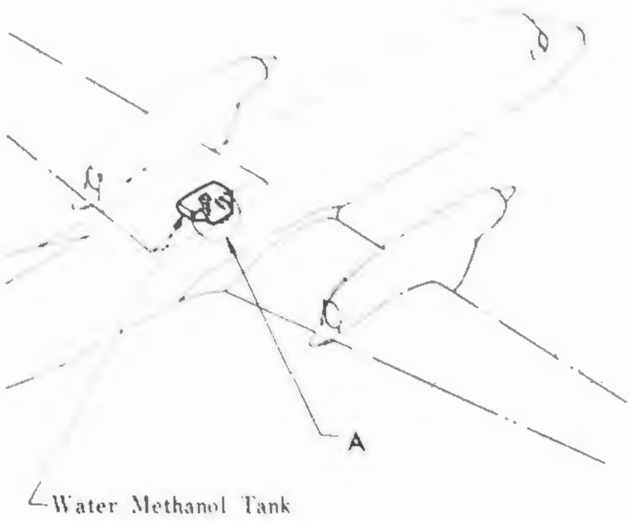


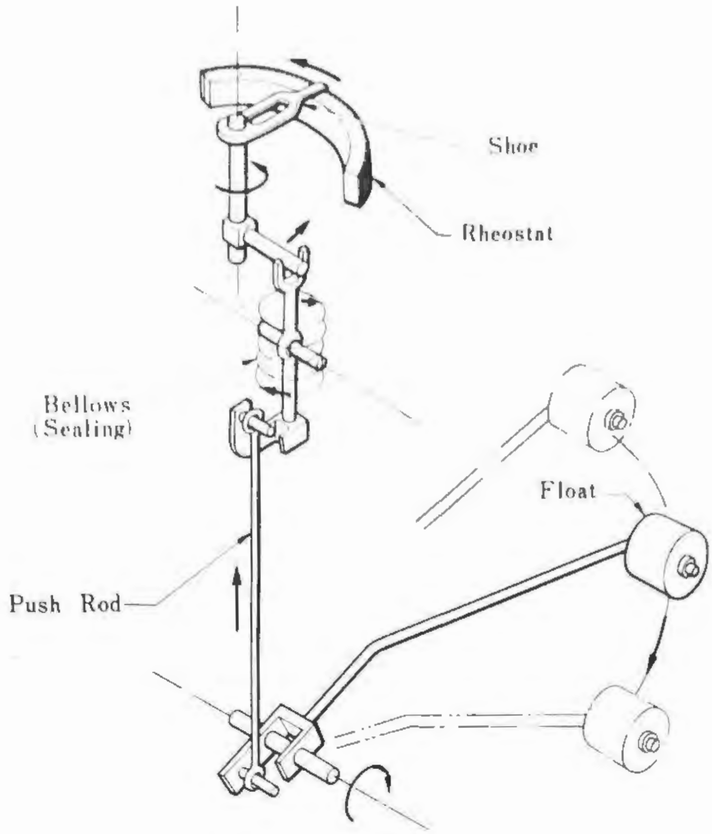
Self Sealing Coupling Cross Section View (Unlock)

W/M Fire Wall Connection
Figure 5–47

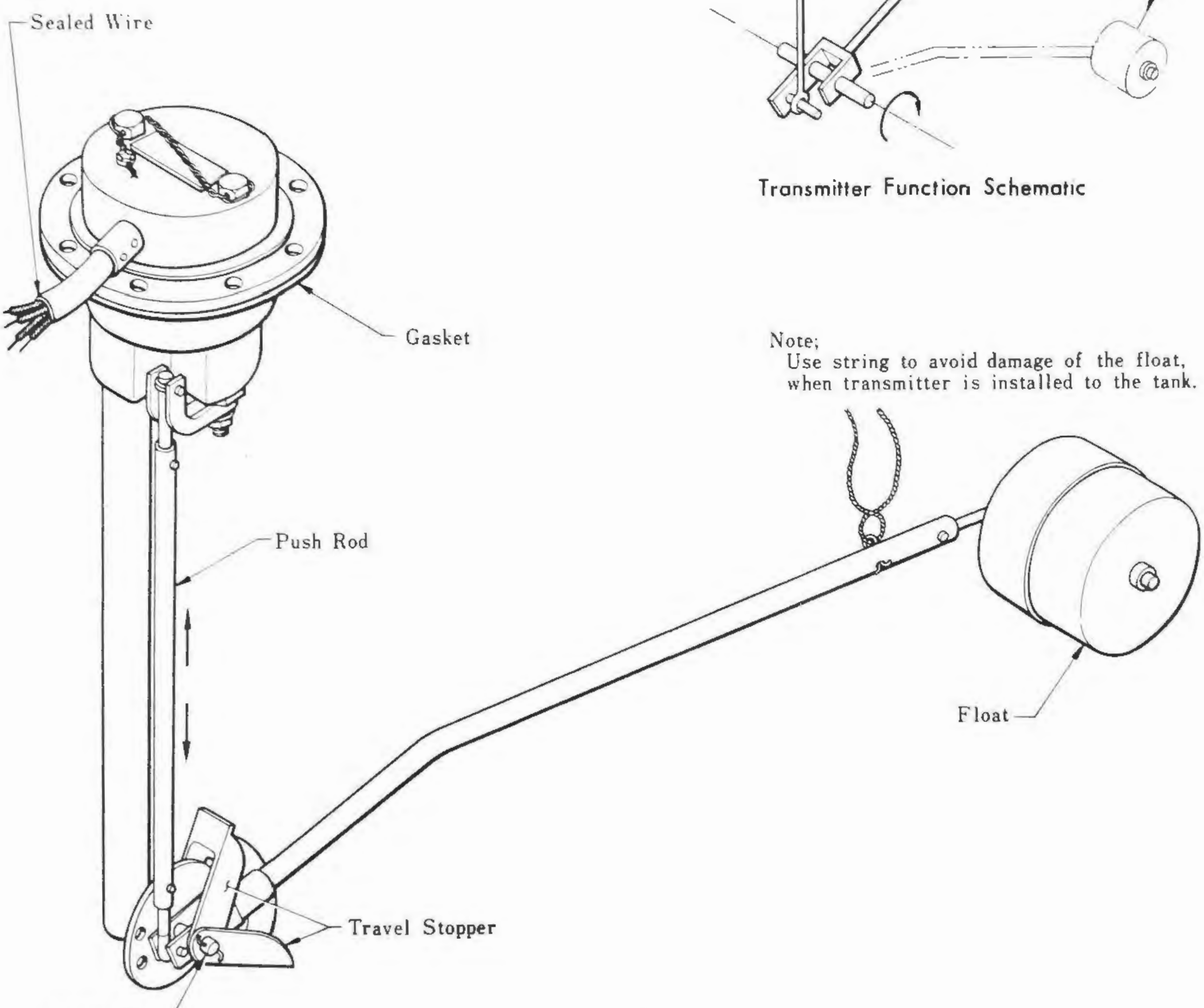


W/M Filter
Figure 5–48



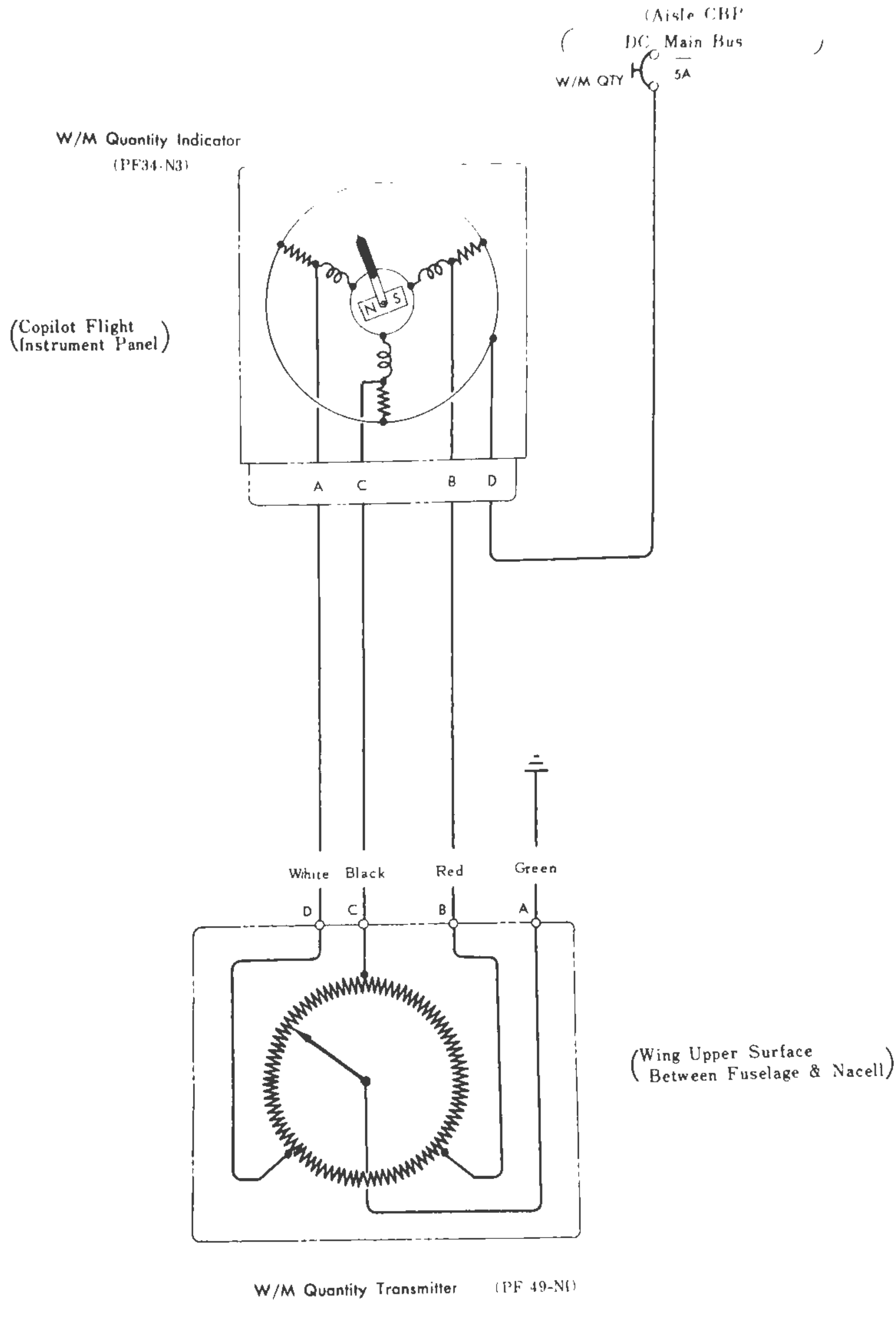


Transmitter Function Schematic



Detail A

W/M Quantity Transmitter
Figure 5–49



W/M Quantity Indicating System Schematic

Figure 5-50

5.9.8 Water/Methanol Pressure Refueling (Fig. 5-51, Fig. 5-52)

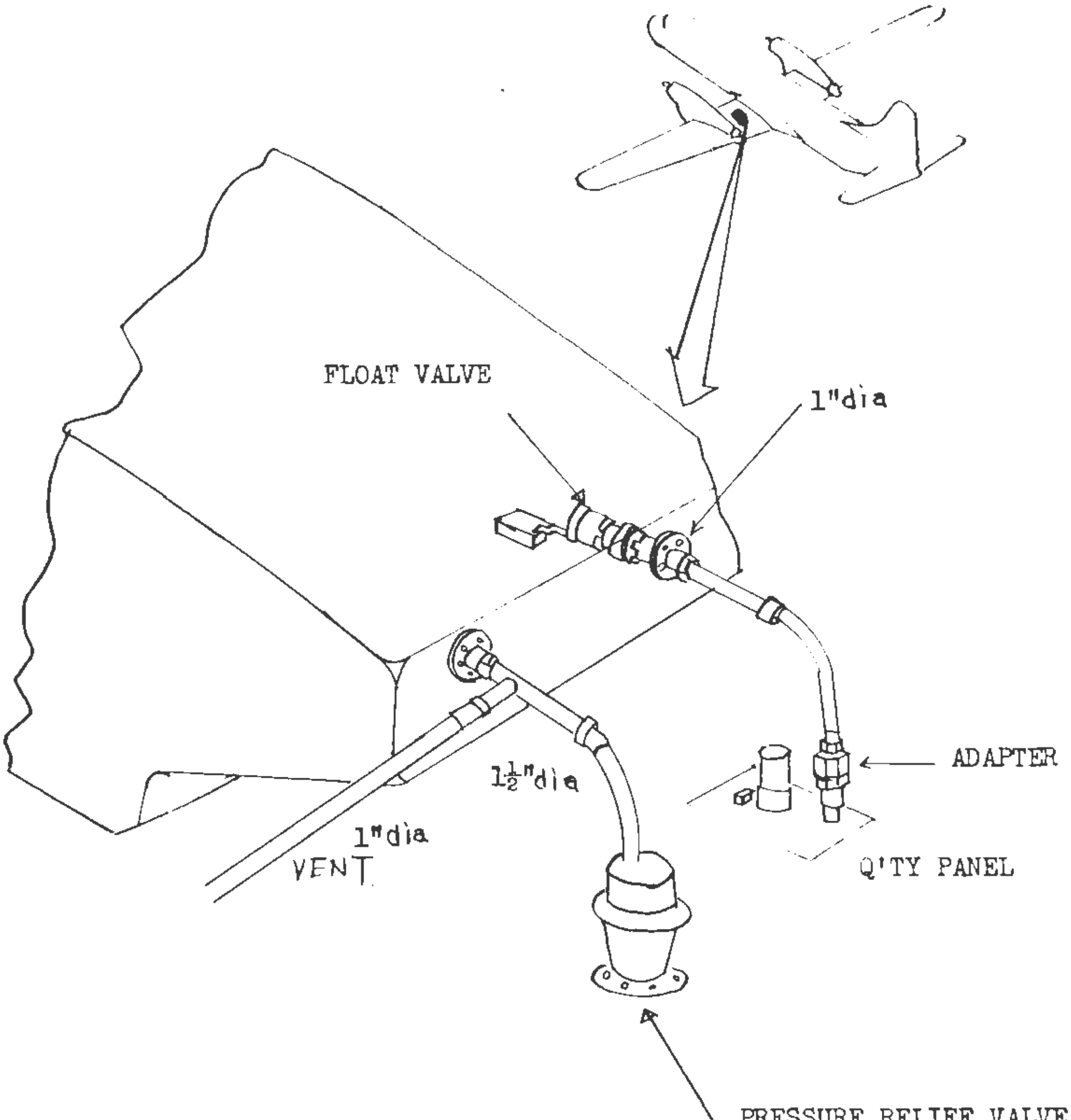
NOTE: The description of this system has been prepared for informational use only since its applicability has not been established yet.

The W/M pressure refueling taking place of the present gravity refueling, supplying W/M from the lower surface of the wing under pressure.

The pressure line uses 1"ϕ pipe and an adapter is provided on the lower surface of the wing.

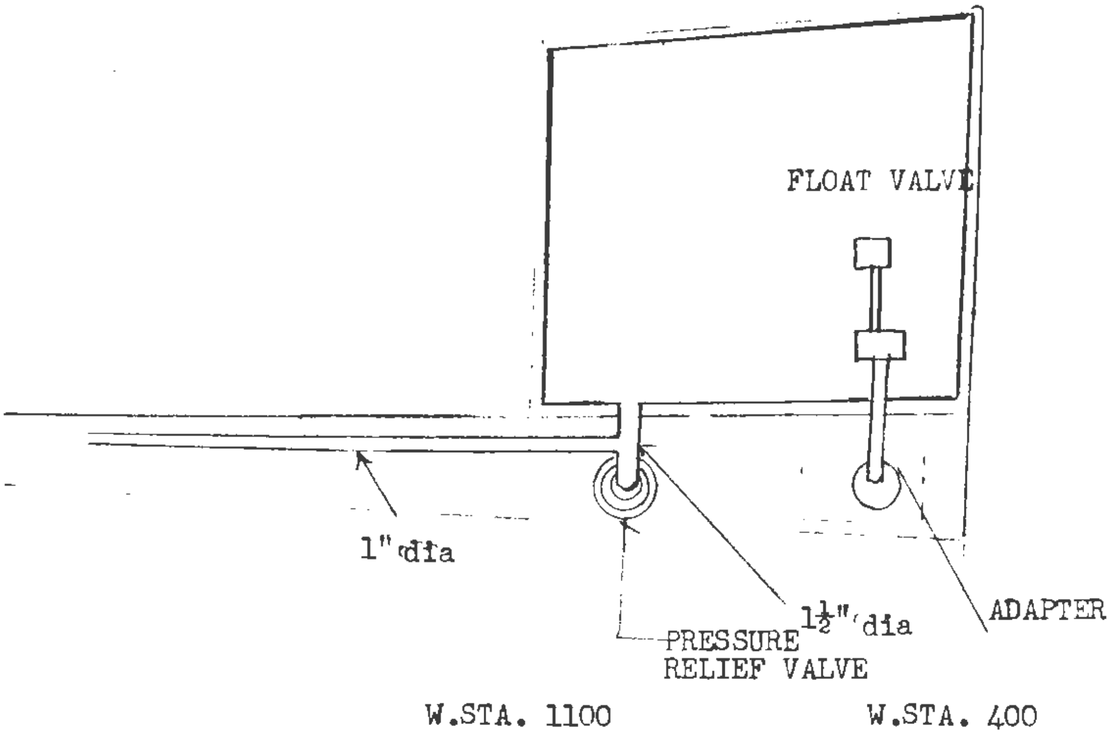
On the panel are provided the quantity indicator, its changeover switch and illuminating lights. A float valve is provided in the tank to shut off W/M supply from the adapter automatically if it reaches a certain level.
Also, in the vent line (1 1/2" ϕ) is located the same pressure relief valve as that used in the integral tank, to relieve the tank pressure at the opening pressure of 1.75 to 1.5 psi.

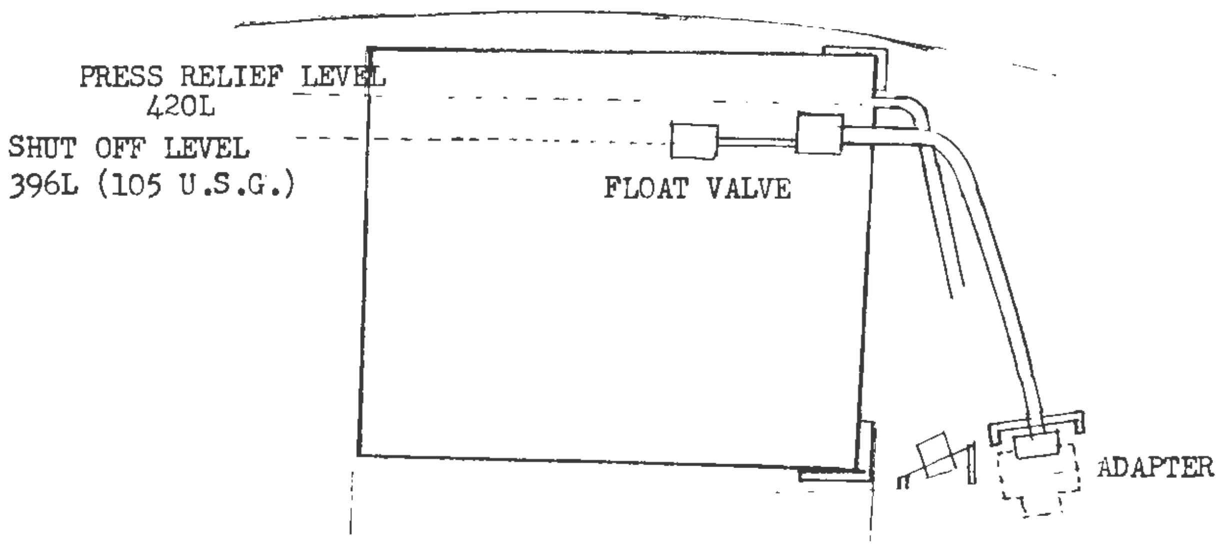
Pressure Refueling Level ...	396ℓ (Approx. 105 U.S.G.) when the flow was shut off.
Gravity "	111 U.S.G.
Pressure Relief Level ...	420ℓ
Maximum Refueling Pressure .	25 psi ... 25 U.S.G./Min.



WATER/METHANOL PRESSURE REFUELING SCHEMATIC

Figure 5-51





WATER/METHANOL PRESSURE REFUELING SCHEMATIC

Figure 5-52

Chapter 6 HYDRAULIC SYSTEM

TABLE OF CONTENTS

Chapter 6 HYDRAULIC SYSTEM

6.1 General

The hydraulic system employed in the YS-11 is of closed center type and consists of main and auxiliary systems.

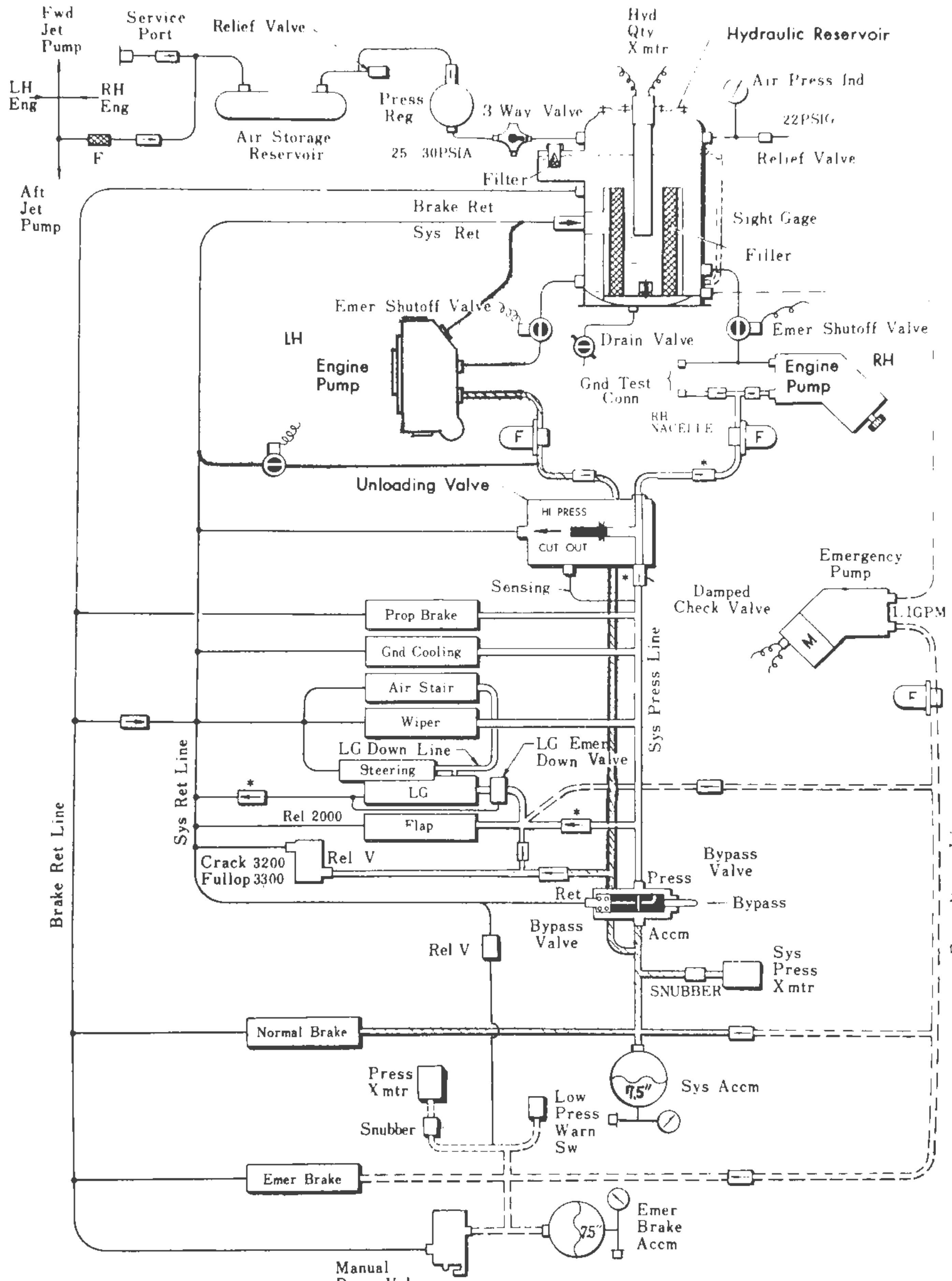
The pressure source consists of two engine driven pumps and one motor driven pump, its system pressure being 3,000 psi. The hydraulic fluid shall conform to MIL-H-5606A. The full capacity of the system is 5[illegible] liters.

Pressure supply system consists of the following nine systems:

	System	System pressure (psi)	Remarks
Non-Essential	Windshield Wiper Ground Cooling Fan Propeller Brake	2000 Approx.1500(Max) 3000	2ea Series
Essential	Landing Gear Steering Flap Stair Way	3000 (Nose Up 2000) 3000 2000 3000(Up) 1200(Dn)	See ch. 3 " See ch. 7
Brake	Normal & Parking Brake Emergency Brake	1200 2300	See ch. 3 "

The control valves for all the operating systems are arranged in the hydraulic compartment. The indicators, warning lights, control switches and control levers of the hydraulic system are arranged in the copilot flight instrument panel.

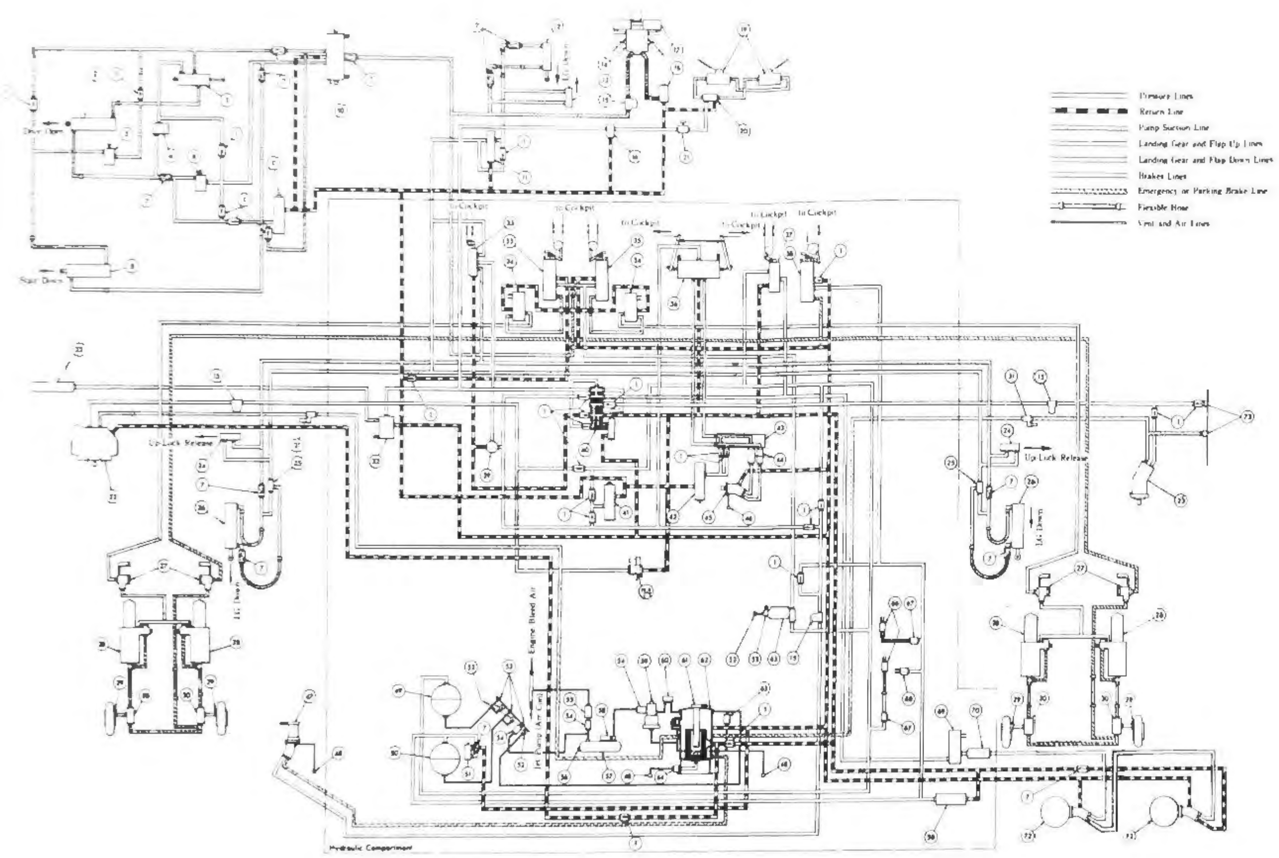
The ground test stand connection is located in the starboard nacelle. It is used in place of the starboard engine driven pump.



*: Installed on Unloading Manifold

Hydraulic Power Schematic

Figure 6–1

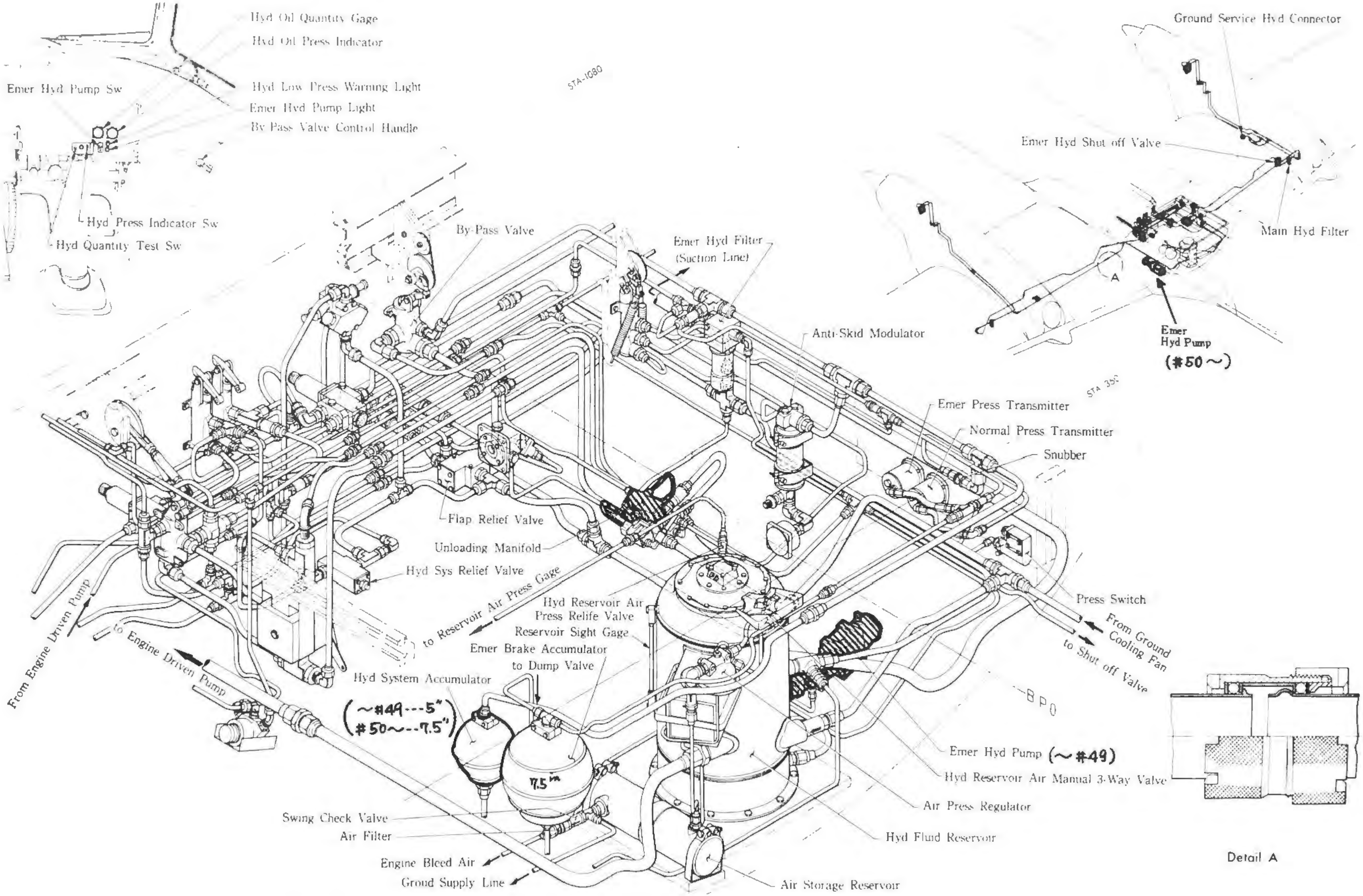


Hydraulic System Schematic Diagram

Figure 6-2

1) Check valve
2) Door actuating cylinder
3) Door lock cylinder
4) Door close sequence valve
5) Door open sequence valve
6) Stair sequence valve
7) Restrictor
8) Stairway actuating cylinder
9) Door relief valve
10) Stairway control valve
11) Reducing relief valve
12) N.L.G. actuating cylinder
13) N.L.G. up-lock cylinder
14) Nose wheel steering control valve
15) Filter
16) Wiper reducing relief valve
17) Nose wheel steering actuating cylinder
18) Back pressure valve
19) Wiper window unit
20) Wiper control unit
21) Wiper speed control valve
22) Propeller brake
23) Engine driven pump-variable delivery
23') Engine driven pump-constant delivery
24) M.L.G up-lock cylinder
25) M.L.G by-pass valve
26) M.L.G actuating cylinder
27) Swivel joint
28) Brake lock-out cylinder
29) Bleeder valve
30) Shuttle valve
31) Emergency shut-off valve
32) Propeller brake control valve
33) Landing gear control valve
34) Anti-skid control valve
35) Power brake valve
36) Flap control valve
37) By-pass valve
38) Emergency brake valve
39) Emergency landing gear release valve
40) Unloading manifold
41) System relief valve
42) Flap relief valve
43) Manifold
44) Flow regulator
45) Flap torque motor
46) Seal drain
47) Emergency hydro pump
48) Exterior drain
49) System accumulator
50) Emergency accumulator
51) Controllable check valve
52) Pressure guage
53) Air charging inlet
54) Swing check valve
55) Air filter
56) Drain plug
57) Air storage reservoir
58) Relief valve
59) Pressure regulator
60) Reservoir change 3-way cock
61) Fluid quantity transmitter
62) Reservoir
63) Reservoir relief valve
64) Drain valve
65) Anti-skid pressure modulator
66) Pressure transmitter
67) Snubber
68) Pressure switch
69) Ground cooling fan shut-off valve
70) Priority valve
71) Pressure reducing relief valve
72) Ground cooling fan
73) Test stand connectors
74) Shut-off valve

#50 ~ 67



Hydraulic Power System
Figure 6-3

6.2 Hydraulic Pressure Source System

6.2.1 Main System

(1) General

This system consists of a hydraulic pressure source system with two engine driven hydraulic pumps, a return oil system from all operating systems, a reservoir and its pressurizing system.

Hydraulic fluid is fed to the engine driven hydraulic pumps mounted on the front of both starboard and port engine gear boxes from the reservoir of the hydraulic compartment by a 1"ø pipe. In the intermediate part (WS. 2000 on the back side of the wing rear spar) of the pipe, an emergency shut off valve is located to shut off oil supply to the pumps in the event of an engine fire.

Pressures of hydraulic oil, regulated at 3000±100 psi in case of the L.H. side variable pump and 2600 to 3100 psi regulated by the unloading valve in case of the R.H. side constant pump are fed to the control valves of eight hydraulically operated systems (except for the emergency brake). When no hydraulic pressure is used during flight, the pump load can be reduced by using the by-pass valve which keeps the unloading valve at rest.

Hydraulic oil used in each system goes back to the reservoir through the following two independent return lines:

(A) System return line,

(B) Brake return line.

The purpose of making these lines independent of each other is to prevent the surge pressure of the system return line from affecting the brakes. While the system return oil goes through the check valve to the filter in the reservoir, the brake return oil passes through neither the check valve nor the filter in the reservoir to facilitate return from the brakes.

(2) Operation Check (System Internal Leak Check)

Connect the hydraulic test stand and ground power unit to the aircraft and set the by-pass lever to NORMAL.

(A) Set the pressure of the hydraulic test stand to 3,000 psi and the flow rate to 10 GPM.

(B) The cut-out and cut-in time shall be more than one minute and 20 seconds.

(C) After another cut-out, set the by-pass lever to By-Pass and stop the hydraulic test stand. At this point, check that the hydraulic pressure gage of the aircraft indicates more than 3,000 psi.

(D) The time required for the hydraulic pressure gage of the aircraft to drop to 2,000 psi shall be more than 30 minutes.

6.2.2 Hydraulic Reservoir

Specifications

Full capacity:	29.0 ℓ
Full oil capacity:	23.5ℓ
Normal oil capacity:	15.7ℓ
Emergency oil capacity:	7.8ℓ
Expansion space:	5.5ℓ
Proof pressure:	50 psi

The hydraulic reservoir is located in the hydraulic compartment and is common to the main and auxiliary systems.

The emergency side suction port is lower than the main side so that even if the hydraulic oil of the main system runs short, 7.8 liters of hydraulic oil can be used by the emergency pump.

The position of the reservoir is lower than that of the engine driven hydraulic pump so that engine bleed air is used for its pressurization.

Brake return with low flow rate goes directly into the center of the reservoir, while system return goes from the return chamber through the filter into the center of the suction chamber. If the filter is blocked, the relief valve mounted on the return chamber is actuated, permitting oil return to the suction chamber without passing through the filter. The opening pressure of the relief valve is 6±0.5 psi, while the closing pressure is 5.3±0.5 psi.

In the center of the reservoir, an oil quantity gage transmitter is suspended from the ceiling. The sight gages have Full and Refill marks to indicate how much oil is contained in both accumulators.

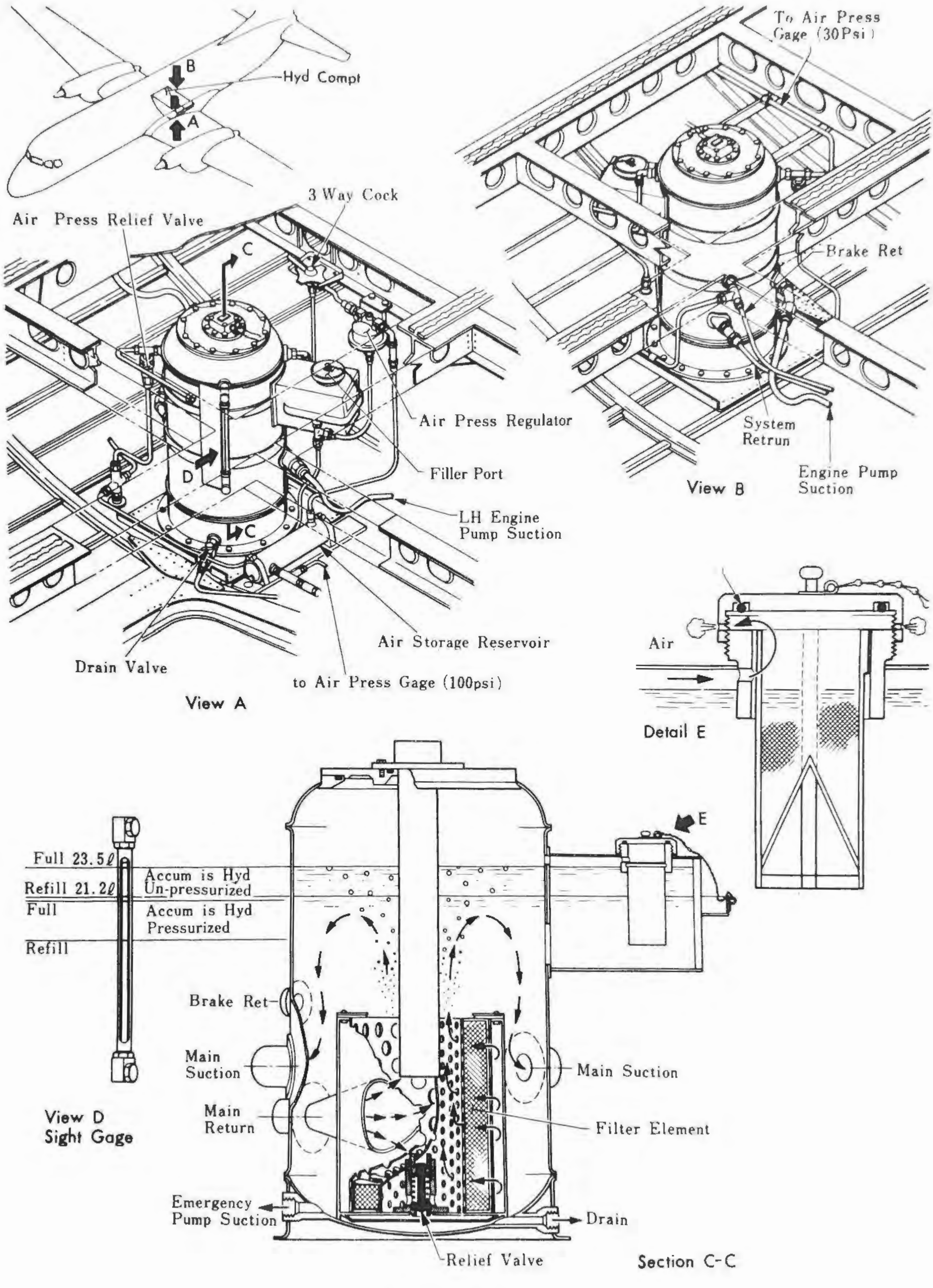
6.2.3 Hydraulic Reservoir Pressurization System (Fig. 6-2)

Bleed air from the 2nd stages of both engine compressors goes through the air filter and swing check valve to the air storage reservoir (located just below the hydraulic reservoir).

This reservoir accumulates 2.1 liters of bleed air and serves as the air pressure source of the hydraulic reservoir.

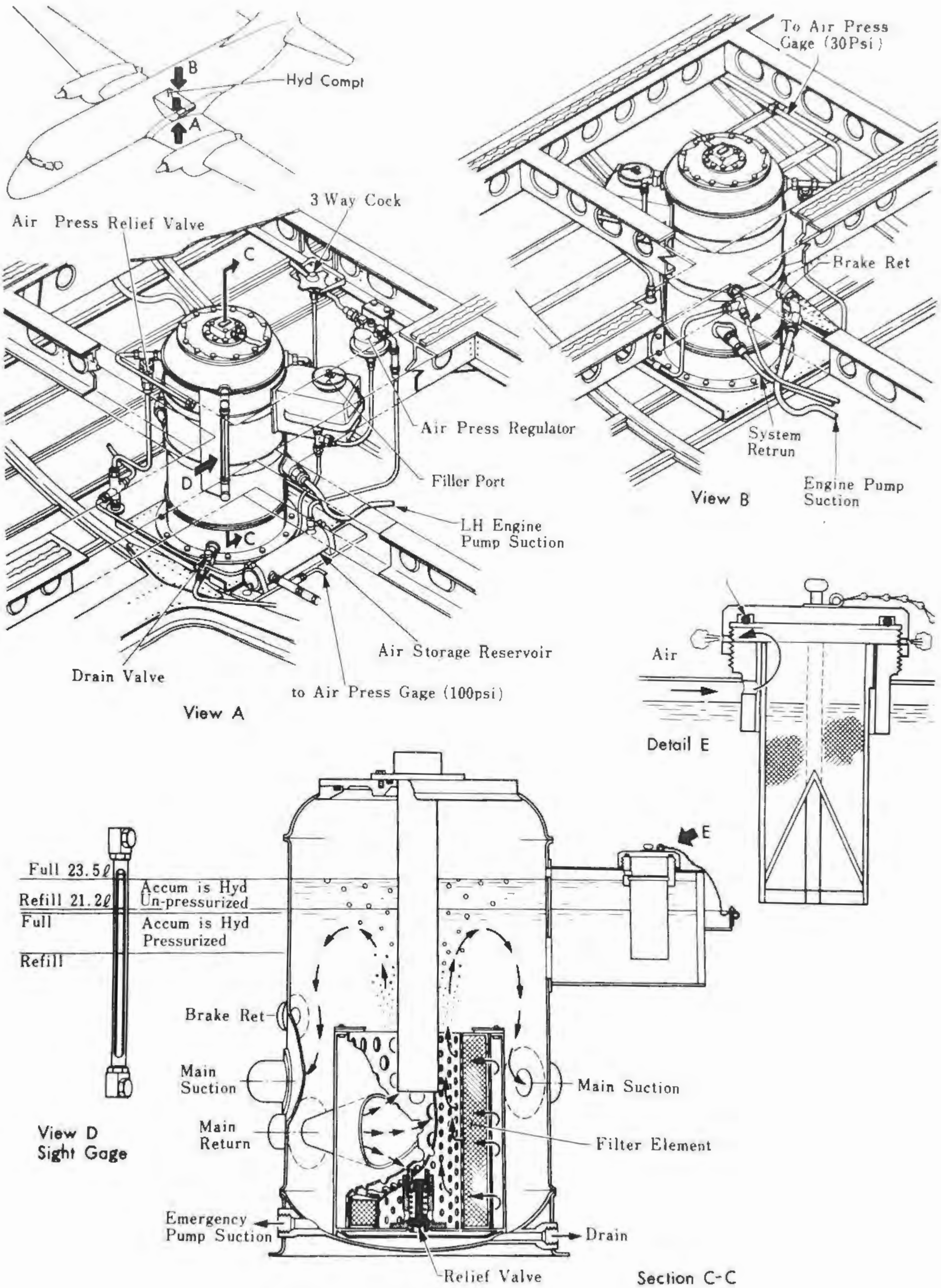
Air from the air storage reservoir goes into the air pressure regulator. Between these, a relief valve is located which holds down the pressure of the air storage reservoir to less than 100 psi.

The air pressure is regulated to 25 to 30 psi by the air pressure regulator and goes through the manual 3-way valve to the upper part of the hydraulic reservoir. With the manual 3-way valve in normal position, air goes from the regulator into the reservoir. To open the hydraulic reservoir, place the valve in closed position, and the air in the air storage



Hydraulic Reservoir

Figure 6–4



Hydraulic Reservoir

Figure 6-4

reservoir is stored, while the air in the hydraulic reservoir is expelled.

At the front right of the hydraulic reservoir, a relief valve is located which relieves the internal pressure of the reservoir when it becomes more than 22 psi higher than the internal pressure of the aircraft.

6.2.4 Engine Driven Hydraulic Pump

(1) General

The L.H. side pump is of variable delivery type and the R.H. side pump is of positive displacement type, both being vickers products.

The delivery rates of the pumps are 8.19 GPM (Max. 8.65 GPM) at cruising in case of the variable delivery type (L.H. side) and 7.80 GPM (Max. 8.25 GPM) at cruising in case of the positive displacement type. The delivery pressure of the pump of the former type is automatically regulated but the pressure of the pump of the latter type is not. Therefore, it requires an unloading valve for the pressure regulation.

(2) Operation Check

(A) Start one engine by normal procedures and set the engine speed to 7,500 rpm.

(B) Set the by-pass lever to Normal.

(C) Check that the hydraulic pressure gage of the aircraft indicates 2,600 to 3,100 psi.

(D) Set the ground cooling fan switch to "ON". Then, check that the hydraulic pressure gage indicates 1,900 to 2,100 psi.

(E) Set the ground cooling fan switch to "OFF".

(F) Start and set the speed of the other engine to 7,500 rpm.

(G) Set the ground cooling fan switch to "ON". Then, check that the hydraulic pressure gage indicates to psi.

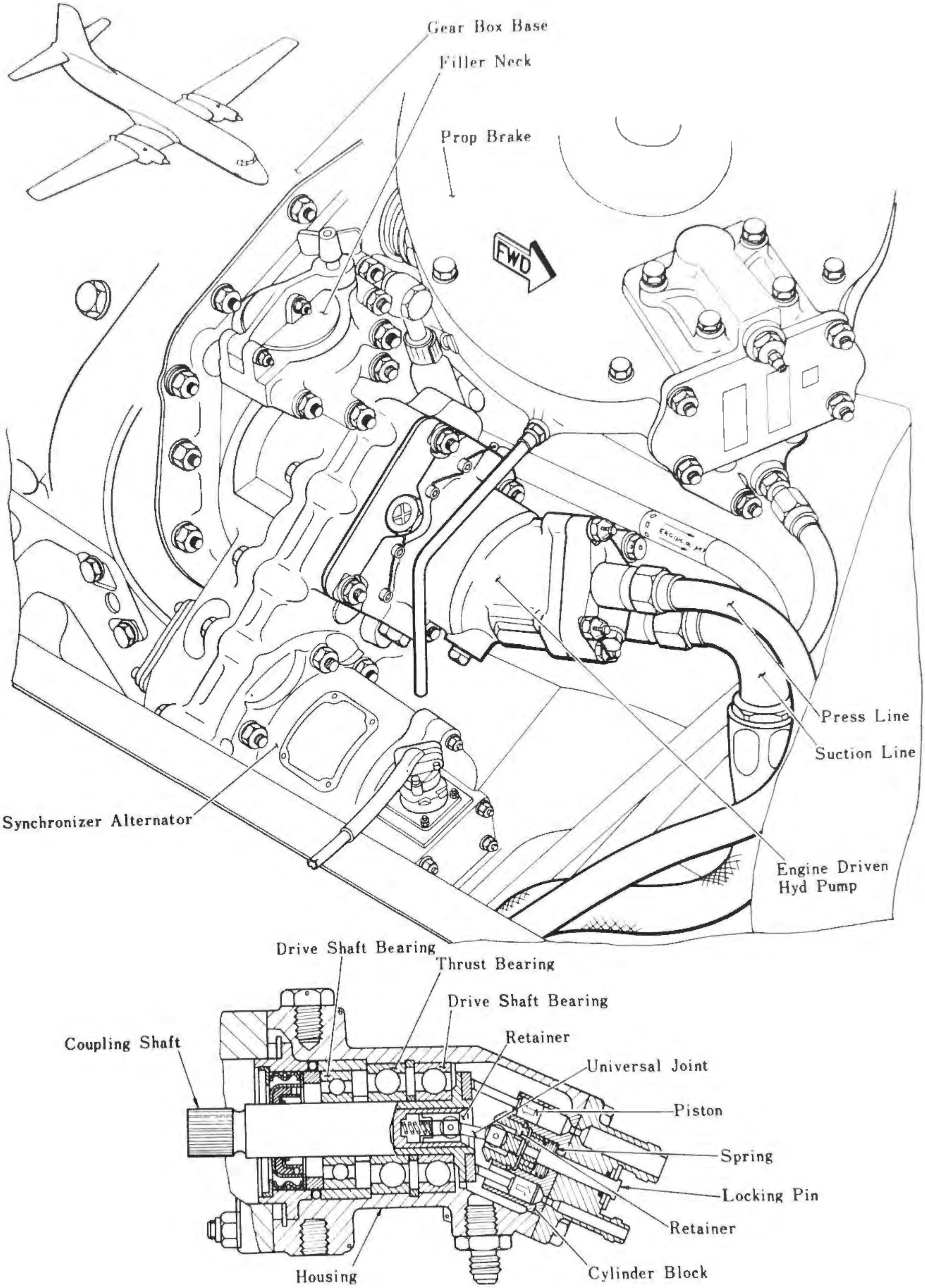
6.2.5 Unloading Manifold

(1) General

This is located just before the maintenance hole of the hydraulic compartment and is designed to regulate the pressure of the main hydraulic system. It is a combination of a manifold, an unloading valve, five check valves, a restrictor and a relief valve.

Hydraulic oil discharged from the engine driven pump goes into the unloading valve, passes through the dash pot check valve, and goes into the manifold where it is distributed among four circuits. One of the circuits leads to the regulator of the unloading valve.

If the system pressure reaches 3,050 to 3,100 psi, the regulator is



Engine Driven Hydraulic Pump

Figure 6–5

actuated, pushing the piston upward and letting the hydraulic oil from the pump escape directly into the return line. (Cut-out) To abate this operation, a restrictor is located in the sensing line. During the slow operation, however, the hydraulic oil from the pump enters the system and increases the pressure too much so that a relief valve is provided which lets the hydraulic oil escape.

The dashpot check valve mounted to the top of the unloading valve prevents the pressure oil from flowing back.

If the system pressure drops to 2,600 to 2,800 psi, the piston comes down and shuts off the return port so that the hydraulic oil from the pump begins to enter the system side again.

In this manner, the system pressure is maintained at 2,575 psi to 3,200 psi at all times through the repeated cut-in and cut-out of the unloading valve.

(2) Operation Check

Connect the hydraulic test stand and ground power unit to the aircraft.

(A) Set the pressure of the hydraulic test stand to 3,000 psi and the flow rate to 10 GPM.

(B) Increase the pressure gradually.

(C) Check that the pressure gage of the test stand drops from 3,050 to 3,100 psi quickly to 0 psi or its vicinity.

(D) Then, check that the hydraulic pressure gage of the aircraft indicates to psi.

(E) While keeping close watch on the indication of the hydraulic pressure gage of the aircraft, make sure that the indication increases quickly to 2,700 psi or its vicinity.

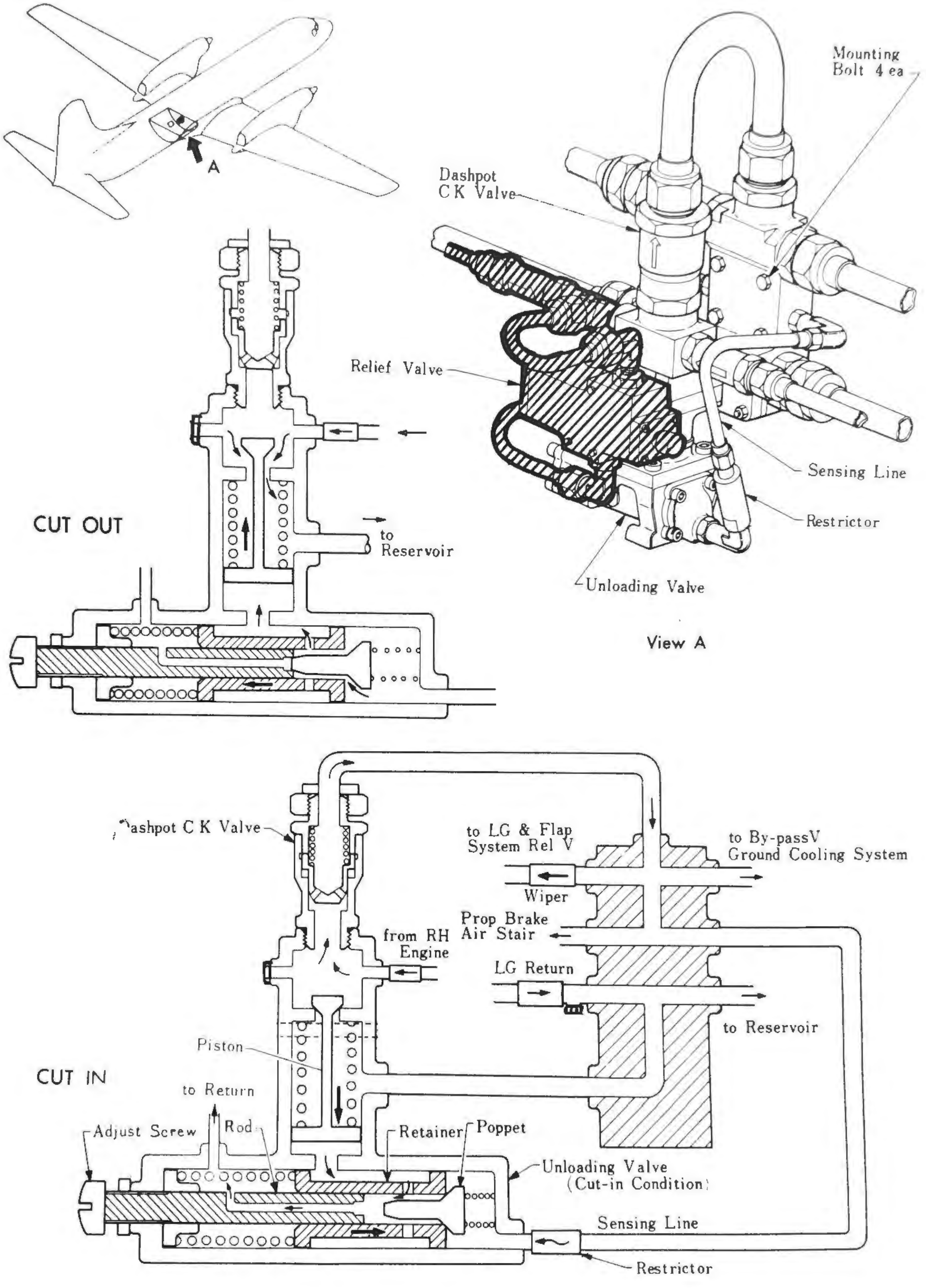
<u>NOTE:</u> After connecting the tⁿst stand, check that the emergency shut-off valve is in opened position.

6.2.6 By-pass Valve

(1) General

This valve is located on the forward wall of the hydraulic compartment and is operated through a cable by the by-pass valve control lever on the right console of the cockpit. The by-pass valve has three ports, "Pressure", "Return" and "Accumulator".
The hydraulic oil from the unloading manifold goes into the "pressure" port and hydraulic oil from variable pump goes into the "Acc" port.

With the valve at "Normal", the pressure port and the accumulator



Unloading Manifold

Figure 6–6

port are connected to each other, and the pressure of hydraulic oil from variable pump is fed to the hydraulical operated system (except for the emergency brake).

At "By-Pass", the pressure port and the return port are connected to each other and the system pressure escapes to the return line, decreasing the loads to the unloading valve and R.H. engine driven pump. Under this condition, the L.H. side variable pump feeds pressure oil to the accumulator and the normal brake system.

(2) Adjustment

The rigging points are shown in Fig. 6-7.

(A) Accomplish adjustment at the "Normal" position.

(B) Make sure that the cable tension is 29±4 lbs (70°F±0.4 lb/°F)

(C) Determine the length of the by-pass valve arm (8) by pressing it down by hand until response is felt.

(D) Adjust the position of the control lever by the adjust plate.

(3) Operation Check

Connect the hydraulic test stand and the external power unit to the aircraft.

(A) Set the pressure of the test stand to 3,000 psi.

(B) Operate the by-pass lever and check that there is no abnormal load

(C) Apply foot pressure on the brakes until the hydraulic pressure gage of the aircraft indicates 0, with the by-pass lever at "By-Pass".

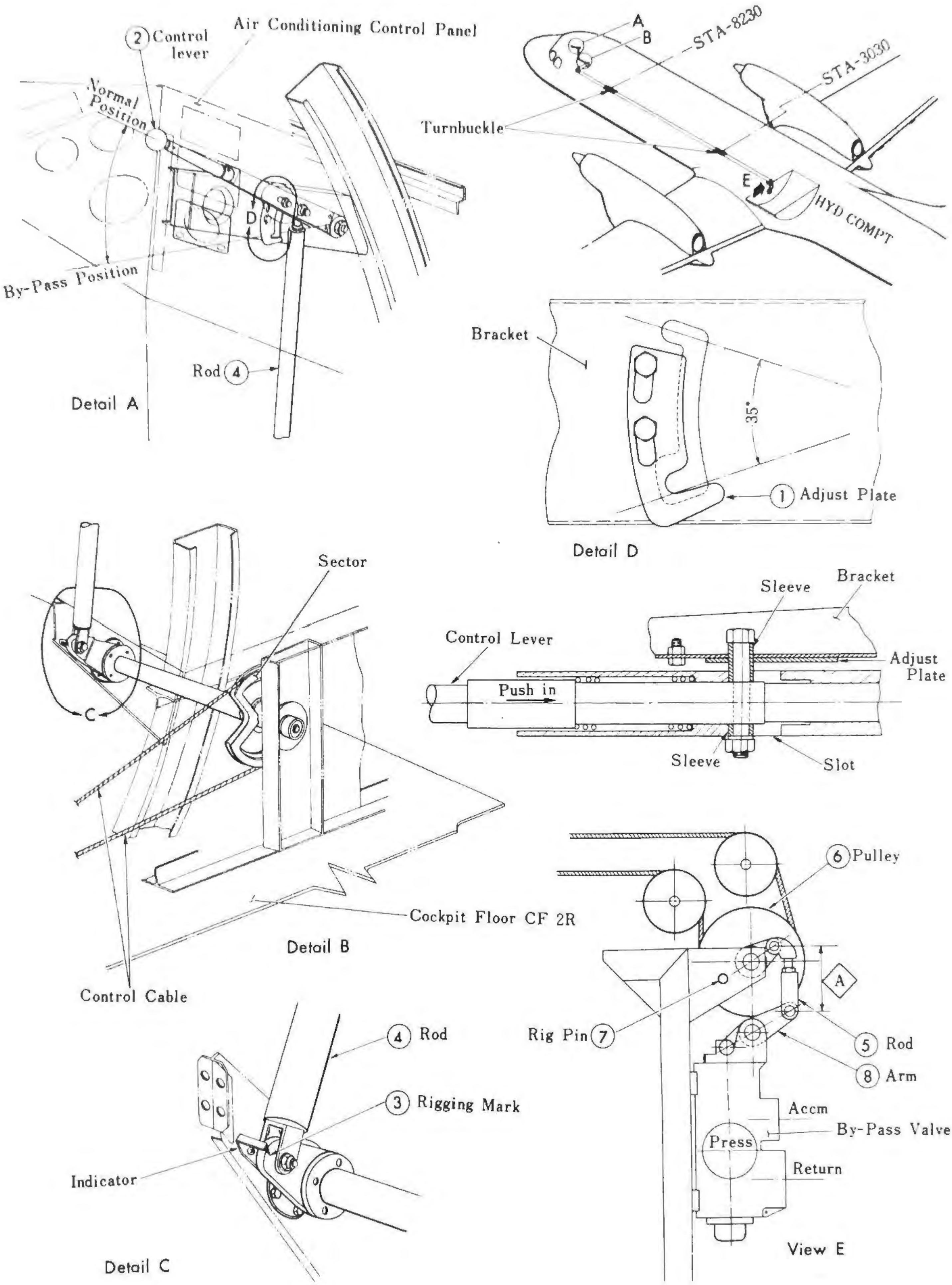
(D) With the by-pass lever in "NORMAL", check that the pressure gage of the aircraft indicates 2,700 psi. Then, move the lever to "BY-PASS".

(E) Check that the indication of the pressure gage of the test stand decreases quickly from 2,700 psi to 0 psi and that the hydraulic pressure gage of the aircraft stays near 2,700 psi.

6.2.7 System Relief Valve

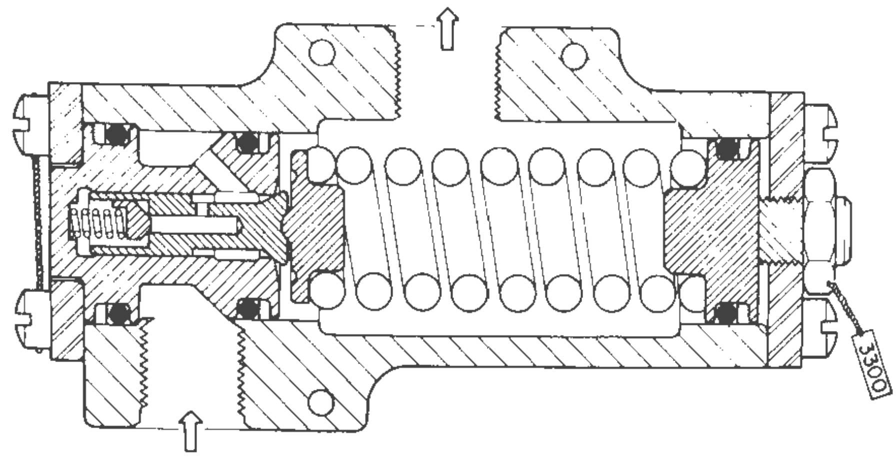
The valve is mounted in front of the man hole in the hydraulic compartment to the left of the flap gear box. This provides system surge pressure relief and serves as a safety device when there is trouble in the unloading valve and the emergency hydraulic pump relief valve.

Opening pressure	3,160 psi
Full opening pressure	$3{,}300\ ^{+50}_{-0}$ psi



By-pass Valve Control System-Rigging

Figure 6–7



Hydraulic System Relief Valve

Figure 6–8

6.2.8 System Accumulator

Two accumulators are located just behind the maintenance hole of the hydraulic pressure compartment.

It is of round diaphragm type and stores approx. 0.55 gal of 3,000 psi hydraulic oil.

With the by-pass valve at "Normal", it operates as an ordinary system accumulator. At "By-Pass", it operates as an emergency accumulator for normal brakes.

6.2.9 Auxiliary System

(1) General

This system consists of an auxiliary pressure source using an emergency motor driven hydraulic pump, piping system and electrical control system.

The reservoir it uses is common to that of the main system but the suction port of the emergency side is lower than that of the main side so that even if hydraulic oil in the main system runs short, 7.8 liters of hydraulic oil can be used.

Power supply for the emergency pump is taken from the DC emergency bus. With the emergency hydraulic pump switch at "ON" or with the stairway selector switch at "Up" or "Down", the pump starts running and the emergency hydraulic pump indicating light (amber) comes on.

The hydraulic oil pressurized by the emergency pump is passed through the filter and is divided among three systems. Among them, there is a line which leads to the emergency pump relief valve. The pressure is regulated by this relief valve. Each of these lines is provided with a check valve. Except for the emergency brake they are connected to the normal system lines, except the emergency brake system. (All return lines are common to the main system.)

The purposes of this system are as follows: The system can be operated even with the by-pass lever at "By-Pass".

(A) As normal hydraulic pressure source

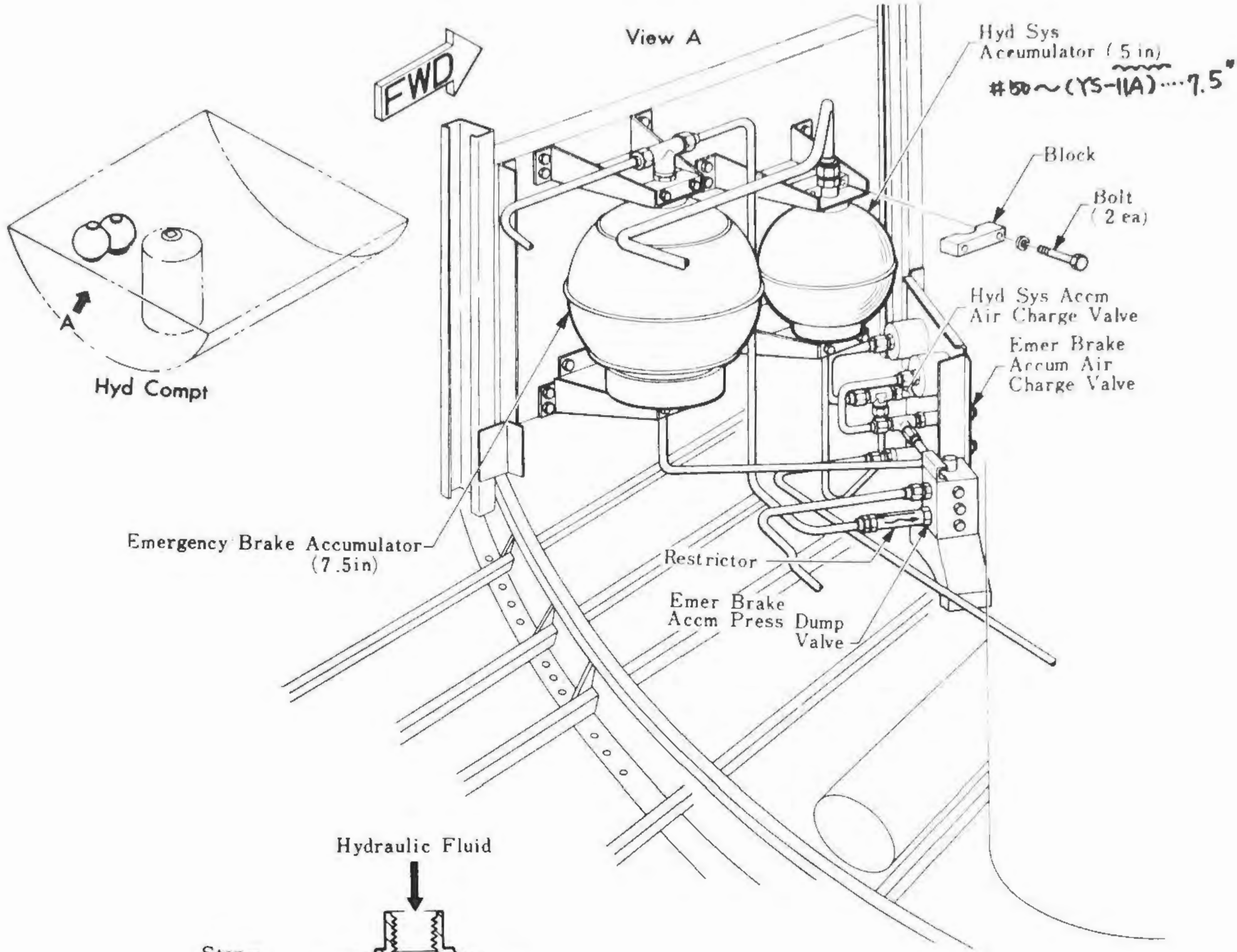
a. For operation of emergency brake system

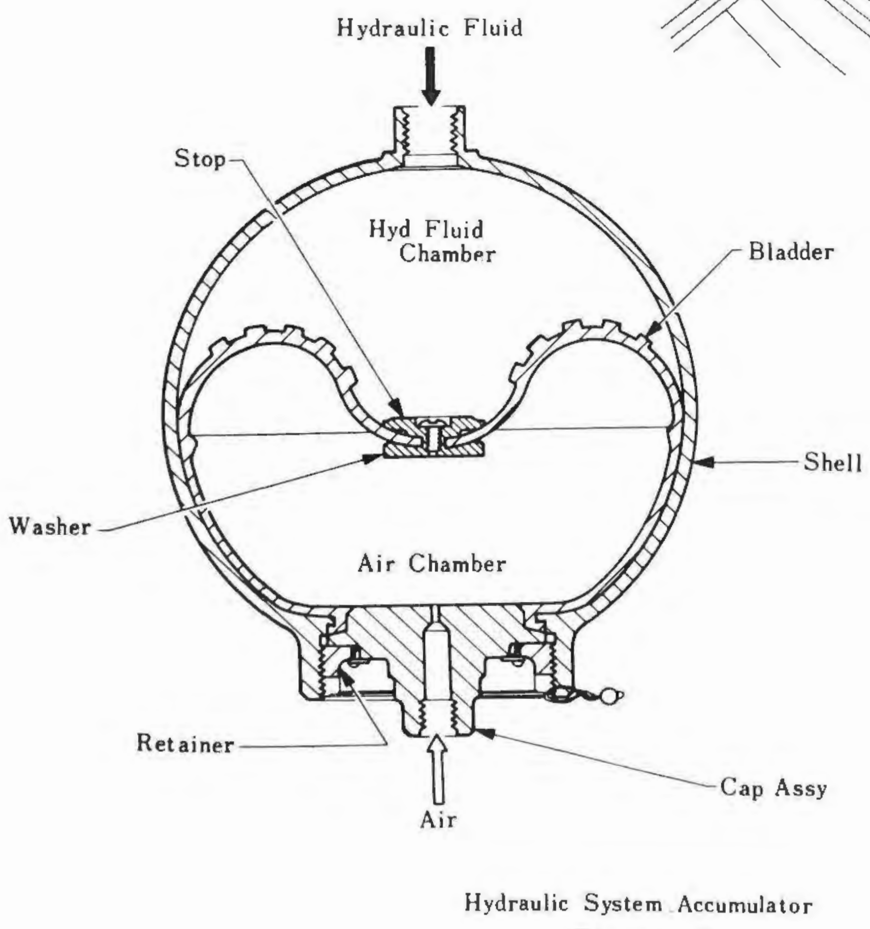
b. For operation of stairway in the event of engine failure

c. For servicing work

(B) As emergency hydraulic pressure source

a. For operation of landing gear control, steering and flap systems.





Hydraulic System Accumulator

Figure 6-9

b. For operation of normal brake system

(2) Operation Check

Connect the external power supply to the aircraft.

(A) Check that the emergency brake accumulator low pressure warning light is ON.

(B) Measure the time between when the emergency hydraulic pump switch is set to "ON" and when the low pressure warning light goes out. The time shall be less than one minute.

(C) Run the emergency pump for another minute. Check that the emergency accumulator pressure is 3,000 to 3,050 psi.

6.2.10 Emergency Hydraulic Pump

The pump is a Vickers product. It is a constant-discharge pump driven by a 28V DC motor located in the rear of the hydraulic compartment, to the right of the hydraulic reservoir. The discharge capacity is 1.1 GPM at 3,000 psi.

6.2.11 Emergency Hydraulic Pump Relief Valve

Located the side of ground cooling fan Priority valve of the air conditioning compartment, it regulates the pressure of the auxiliary system.

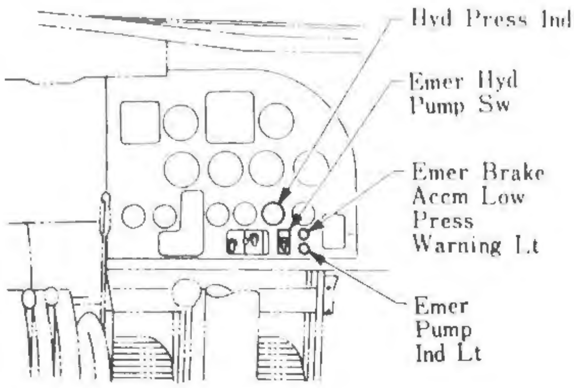
The relief pressure is $3{,}000^{+50}_{-0}$ psi.

6.2.12 Indicating System

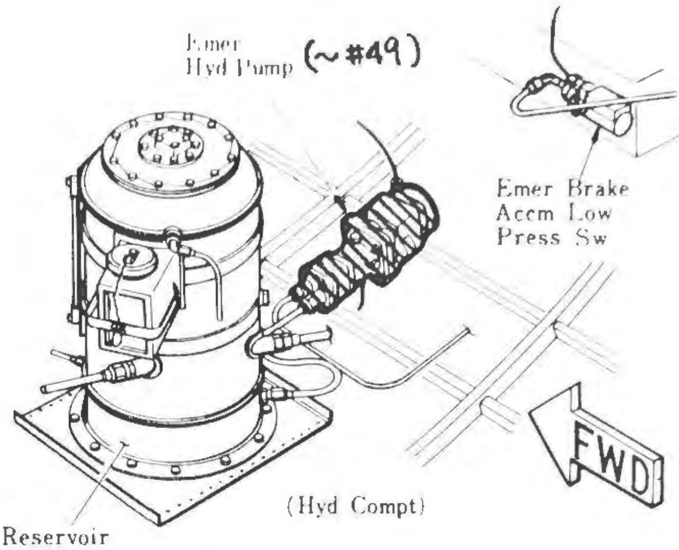
As indicators for the hydraulic pressure system, the following are provided on the copilot flight instrument panel.

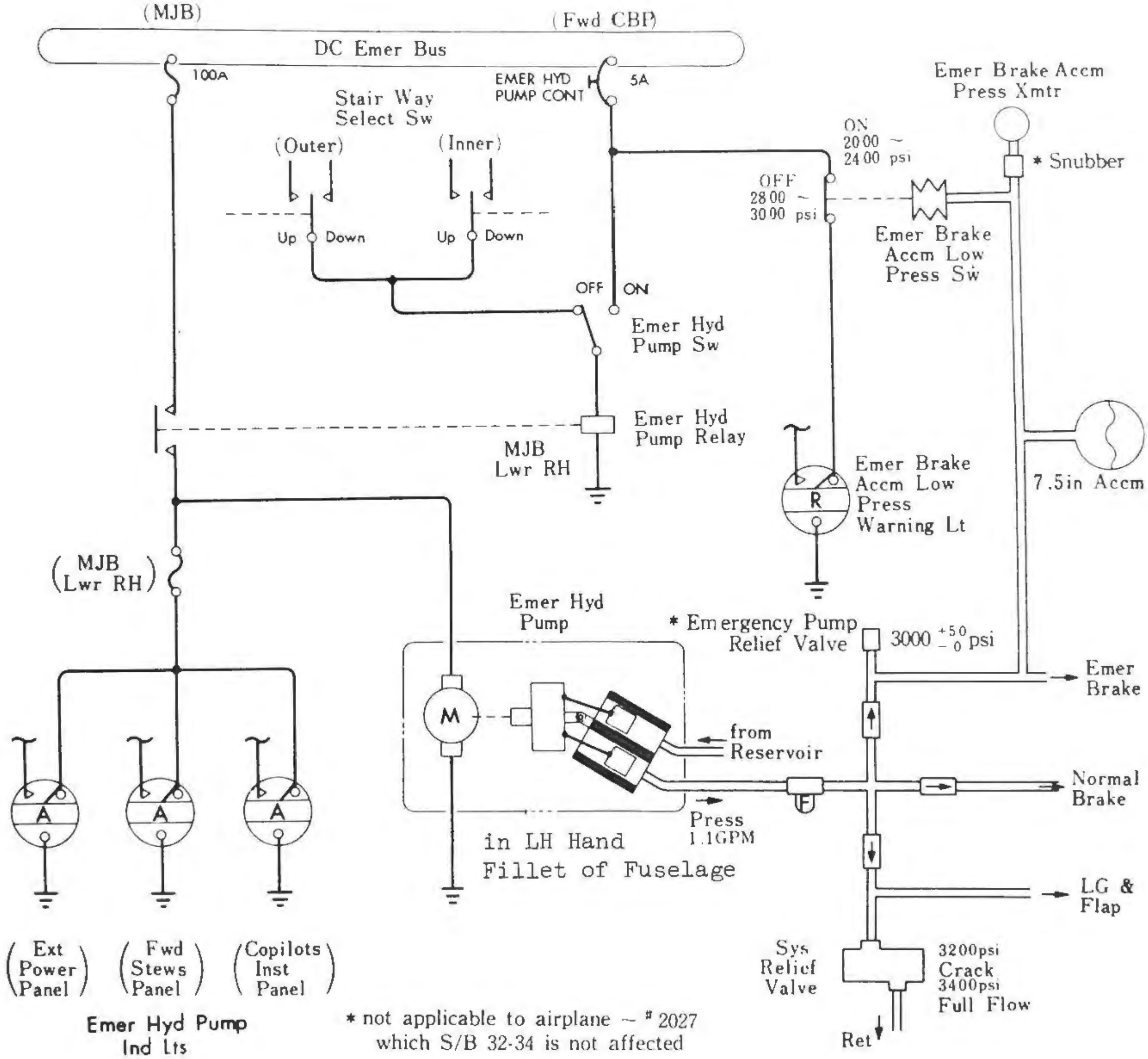
Hydraulic quantity indicator
Hydraulic pressure indicator
Emergency brake accumulator low pressure warning light

<u>NOTE</u>: Refer to the Instrument System.



Copilots Inst Panel





* not applicable to airplane ~ # 2027 which S/B 32-34 is not affected

Emergency Hydraulic Pump Control System

Figure 6–10

6.3 Windshield Wiper

6.3.1 General

On the front of the windshield, hydraulically driven wiper blades are provided to remove water and rain drops. The wiper control knob is located on the left console of the cockpit. The wiping speed of the wiper is adjusted by this control knob.

The wiping angle of the wiper blade is 74°. Even if one blade is frozen, the other one can continue its operation.

The wiper consists of:

(1) Window unit

(2) Control unit

(3) Speed control unit

6.3.2 Operation (Fig. 6-11)

If the speed control valve is opened, the hydraulic oil with pressure reduced to 2,000 psi by the wiper reducing valve goes into the control unit.

(1) The hydraulic oil acts on the right end of the lock valve, pushes the valve toward the left, and opens the oil path which leads to the window unit.

(2) At the same time, since the directional valve has the pilot valve held toward the left, it is pushed toward the left by hydraulic oil.

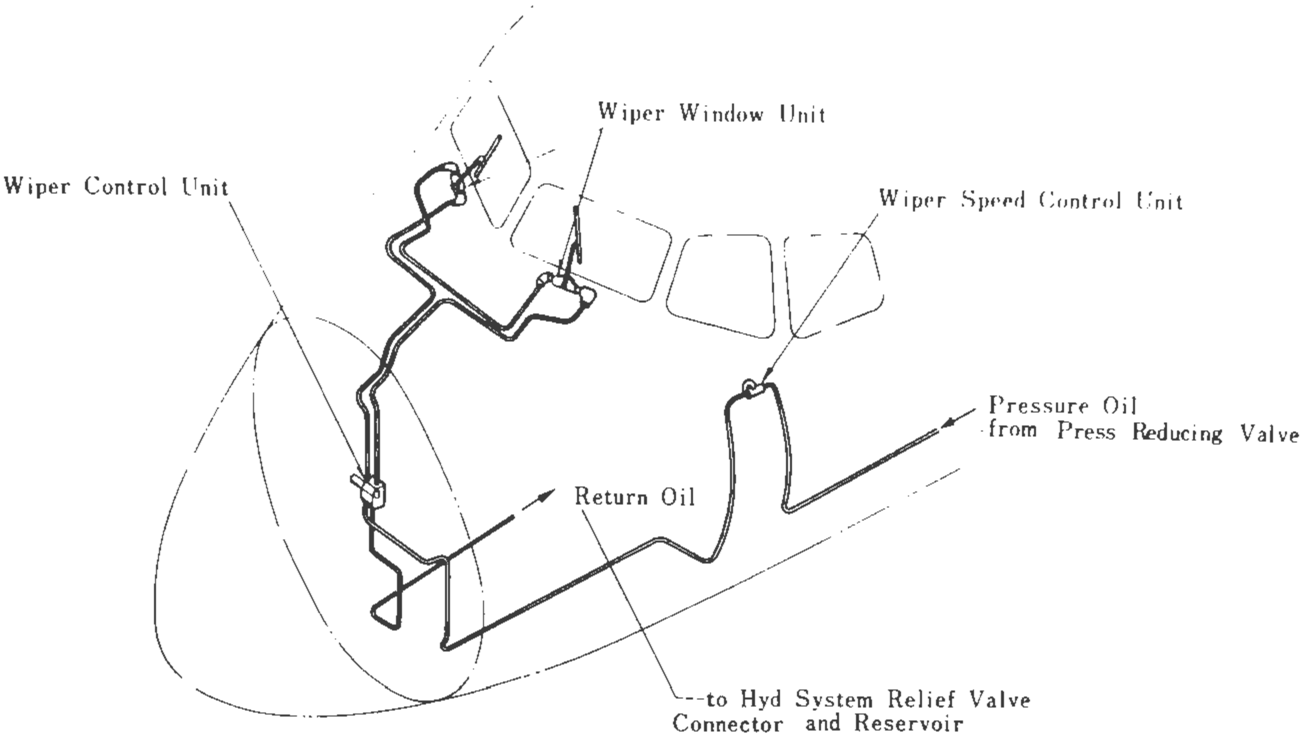
(3) As a result, the right side of the two oil paths from the lock valve to the window unit permits hydraulic oil flow, while the left side permits return flow.

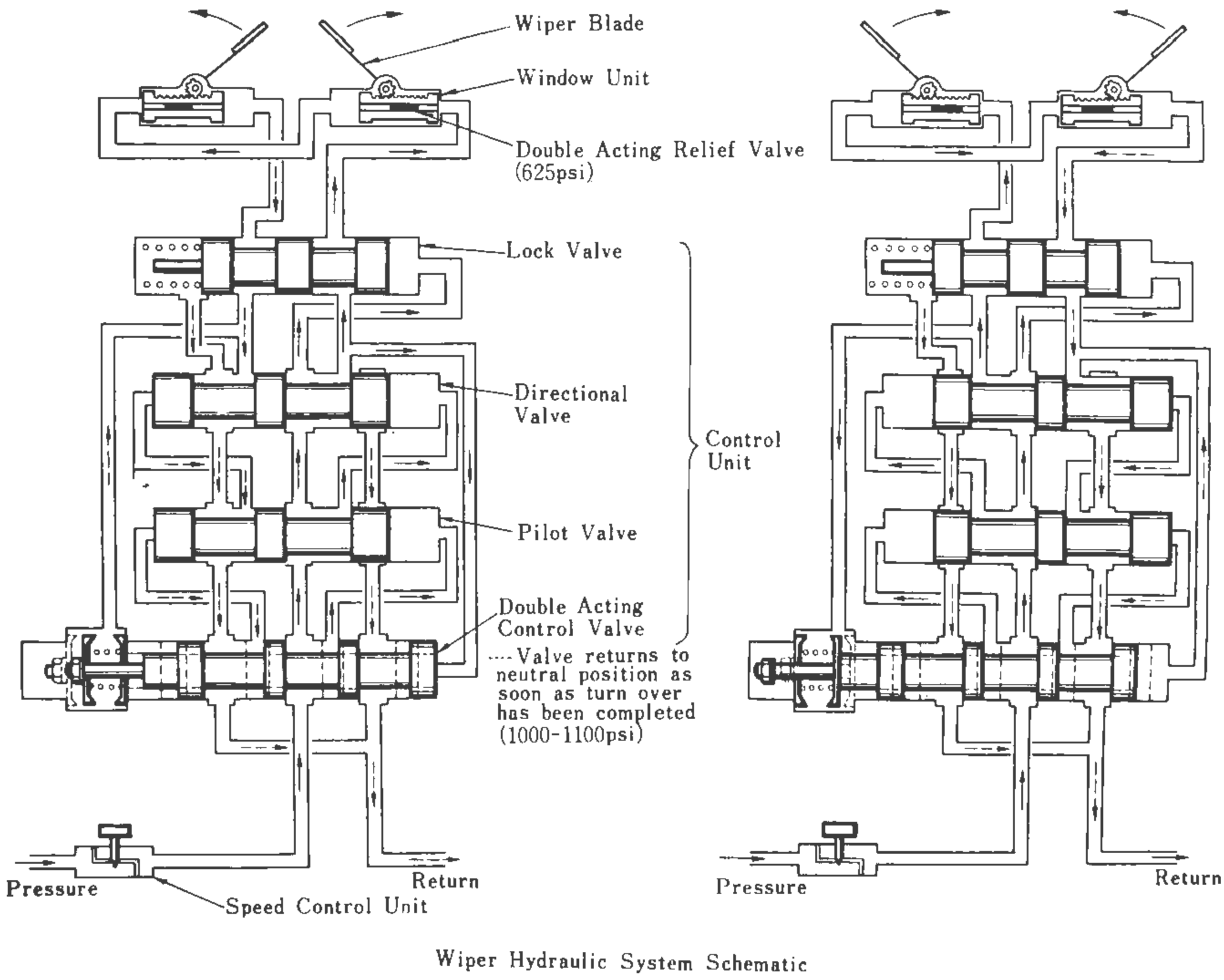
(4) The piston in the window unit is moved inward by hydraulic oil, while the wiper blades are rotated outward.

(5) If the piston in the window unit reaches its extreme end, the hydraulic pressure rises to 1,000 to 1,100 psi, acts on the right end of the double acting control valve, and pushes the valve to the left. This switches the hydraulic oil path to the pilot valve and directional valve in that order. Then, the control valve returns to the original neutral position and fixes the pilot valve.

The blades are moved inward.

(6) If the speed control valve is closed, the directional valve is placed in freely movable condition because the oil pressure dies out. The lock valve is pushed to the right by a spring, closing the two oil





Wiper Hydraulic System Schematic

Figure 6-11

paths to the window unit, and stopping blades.

6.3.3 Operation Check

(1) The speed shall be 400 strokes or more with the speed control valve in fully opened position.

(2) It shall perform smooth operation even at 150 strokes or less.

(3) Even if one blade is held with fingers, the other shall be able to function normally.

NOTE: Sprinkle water over the front surface of the windshield before the check.

6.3.4 Window Unit

At the lower right and left ends of the auxiliary panel, is located the unit which contains a piston and wiper shaft in its body. At the end of the wiper shaft, a wiper blade is located. Inside the piston, a sleeve type relief valve is provided. This relief valve is a double acting relief valve. If the piston stops operation and the oil pressure exceeds 625±10 psi, this relief valve relieves pressure. Because of this function, even if one of the two units becomes inoperative, the other continues normal operation. If both units reach the extreme end, the oil pressure becomes 1,000 to 1,100 psi because these units are arranged in series. The pressure acts on the control unit and switches the hydraulic and return oil paths.

This enables the wiper to repeat reciprocating operation.

6.3.5 Control Unit

This is a unit to switch the oil paths to the window unit and to enable the wiper blades to repeat reciprocating operation. It is located on the front of the seal wall in the upper part of the nose gear well.

It consists of the following four valves:

(1) Double Acting Valve

If the two pistons in the window units reach the extreme end and the oil pressure increases to 1,000 to 1,100 psi, the valve is pushed toward one side and switches the oil path leading to the pilot valve, thus reversing the direction of oil pressure to the window unit. If the window unit operation is switched, this valve returns to the neutral position and locks the pilot valve in that position.

(2) Pilot Valve

The oil paths to the directional valve are switched by this valve.

(3) Directional Valve

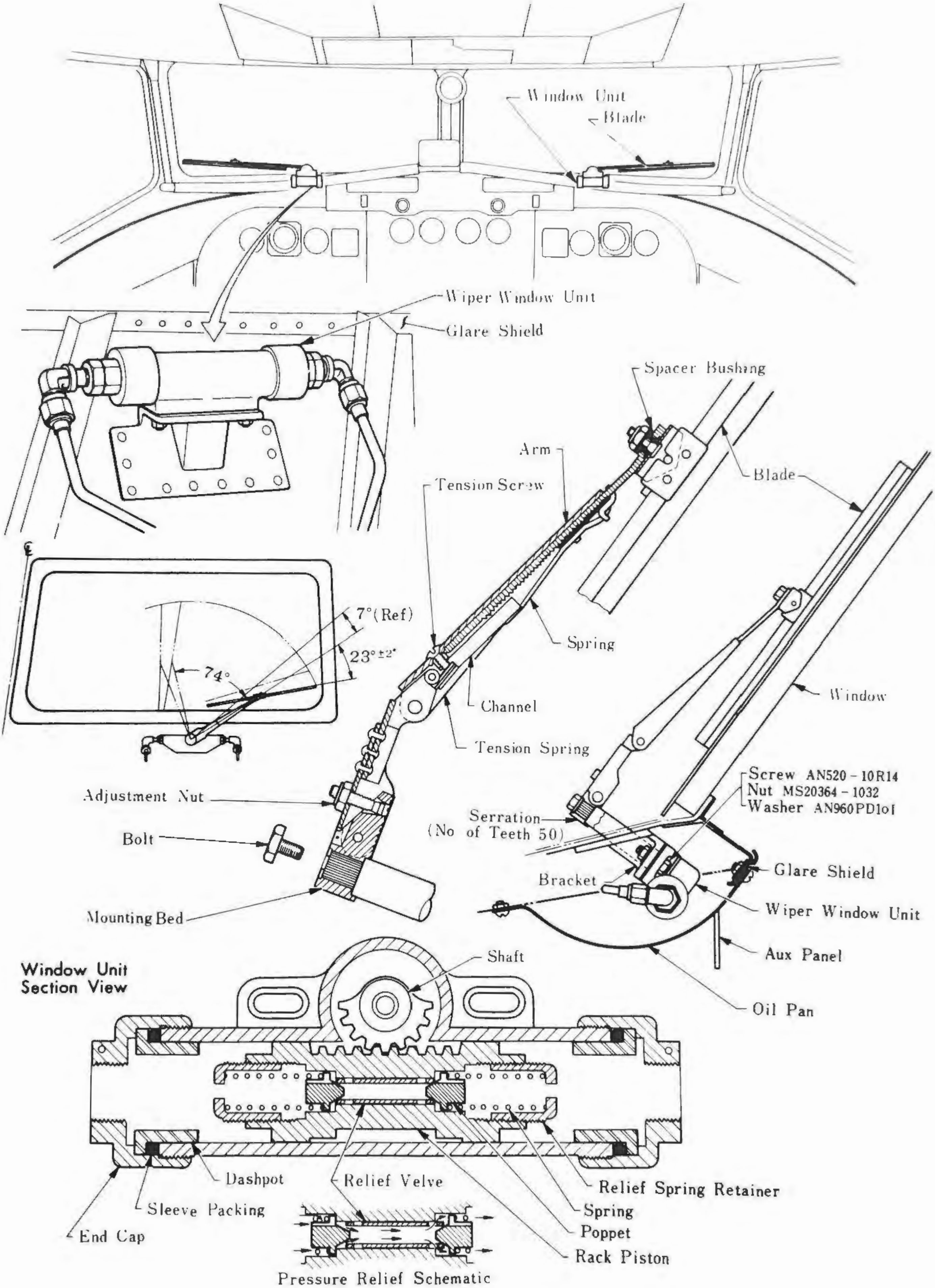
The oil paths to the window units and double acting valve are switched by this valve.

(4) Lock Valve

This valve locks the stationary window units to prevent their unnecessary motion.

6.3.6 Speed Control Unit

Located on the top of the pilot LH console, it controls the oil quantity by a needle valve and orifices and changes the operating speed of the wiper blades.



Wiper Window Unit and Wiper Blade

Figure 6–12

6.4 Ground Cooling System

6.4.1 General

This is an auxiliary system to be used when the aircraft is on the ground and no sufficient cooling ram air is available from the heat exchanger.

6.4.2 Operation

If the ground cooling fan switch of the RH console is set to "ON", the light (amber) comes on, the shut-off valve opened, and the hydraulic oil goes to the priority valve.

The priority valve is opened when the oil pressure reaches 2,100 psi, and the hydraulic oil drives the ground cooling fan. If the oil pressure drops to 1,900 psi, the priority valve is closed and the hydraulic oil blocked to secure brake pressure.

The two ground cooling fans are connected in series and the return line is provided with a restrictor (orifice) in order to subdue the pressure pulsation.

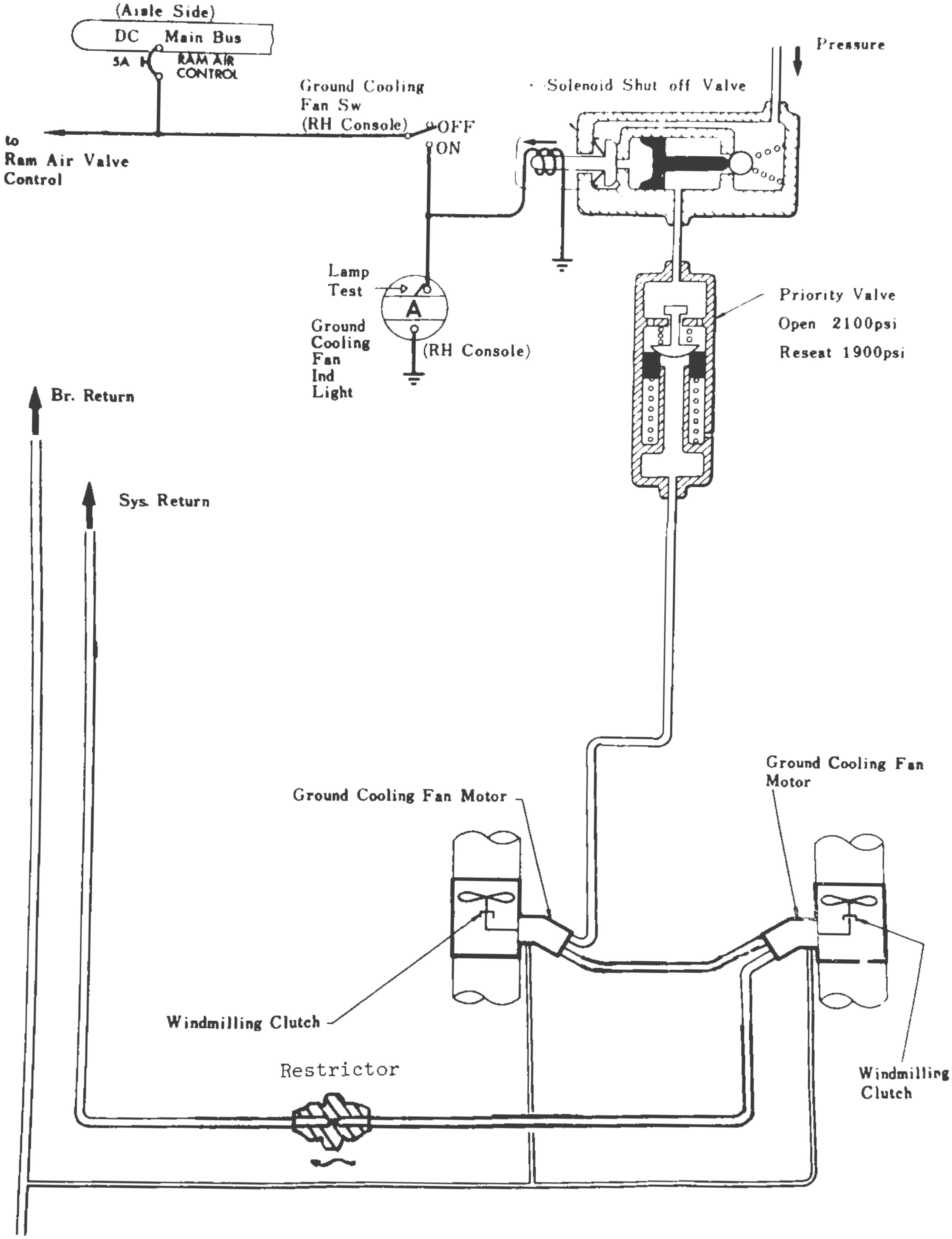
The ground cooling fan motors are approx. 50HP hydraulic motors and drive the fans mounted on the primary and secondary heat exchangers.

During the time the hydraulic motors are at rest, the fans alone can be idled by ram air.

6.4.3 Operation Check

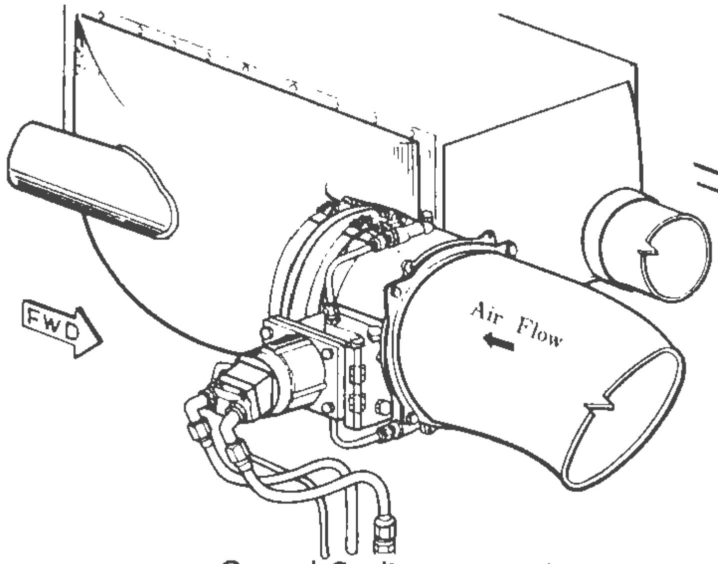
(1) Increase the oil pressure of the aircraft and check that the cooling fans start running at 2,100 psi.

(2) Lower the oil pressure of the aircraft and check that the fans cease to rotate at 1,900 psi minimum.

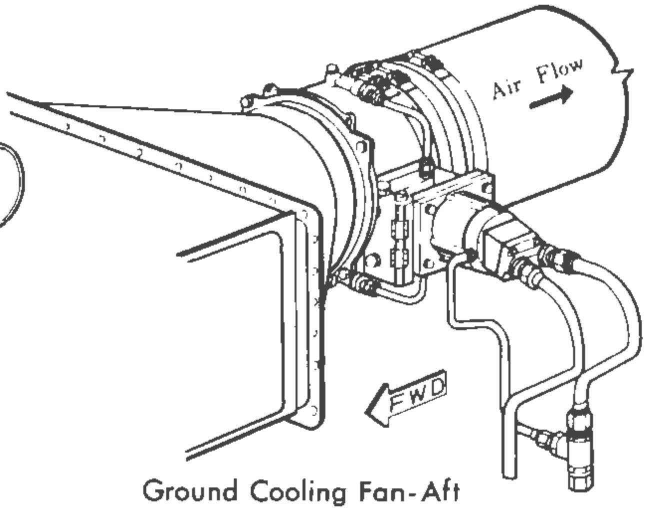


Ground Cooling System Schematic

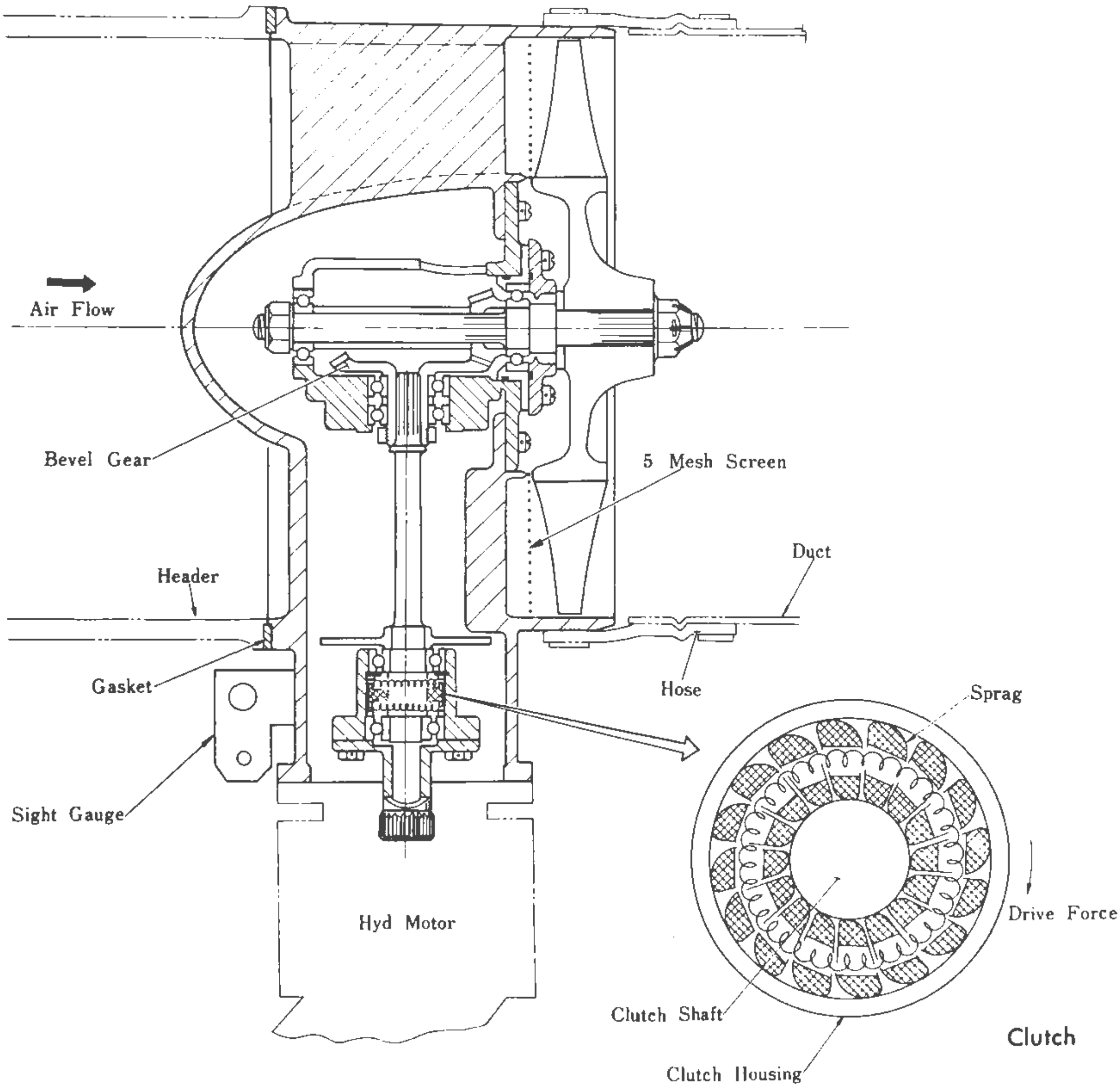
Figure 6-13



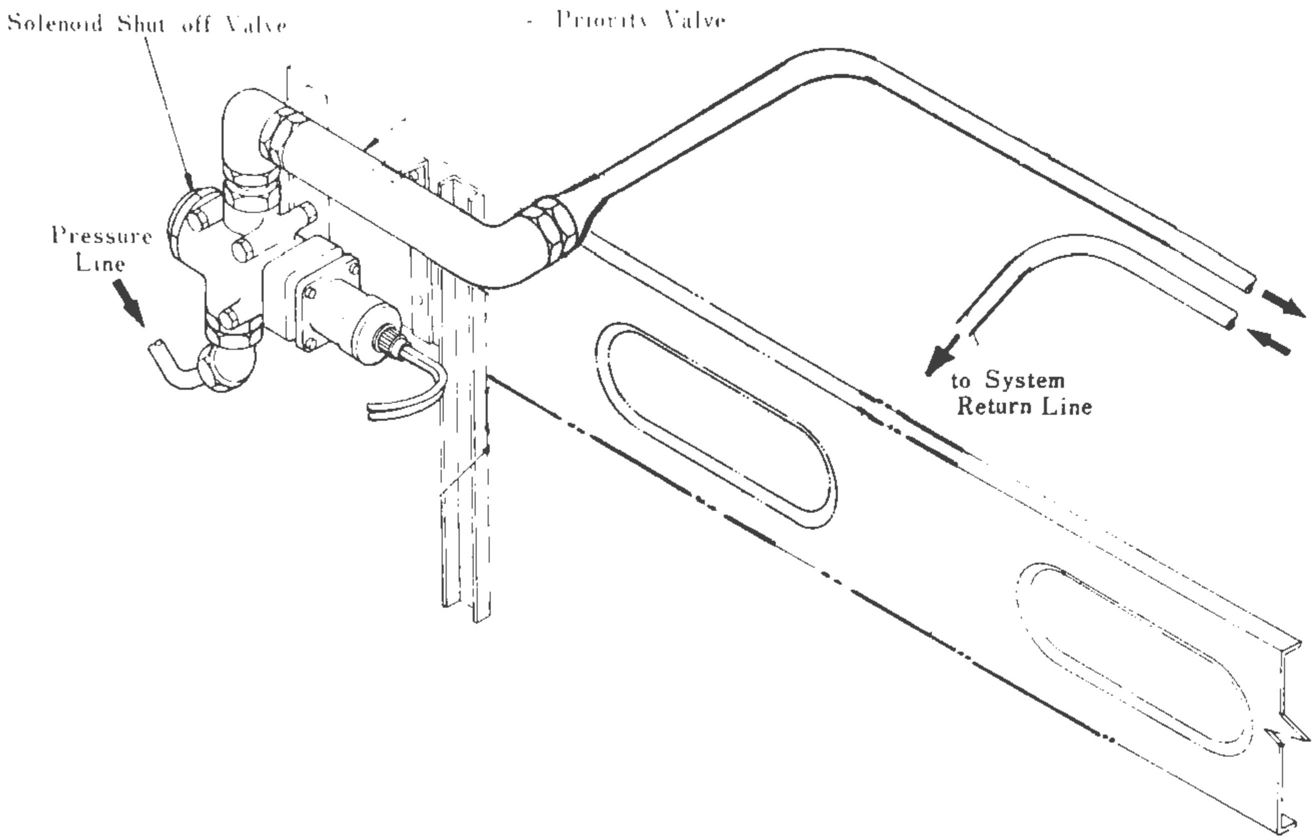
Ground Cooling Fan-Fwd

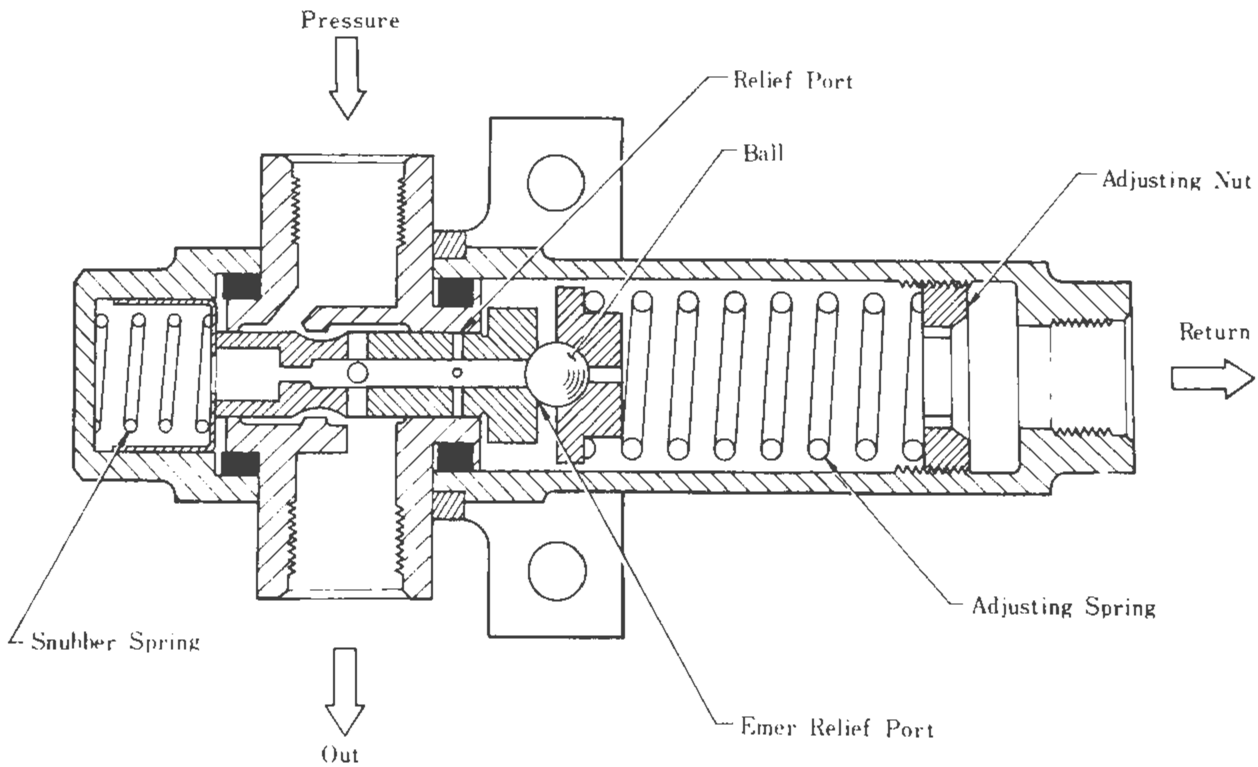


Ground Cooling Fan-Aft



Ground Cooling Fan
Figure 6-14





Ground Cooling Hyd Pressure Reducing Valve

Figure 6-15

6.5 Propeller Brake System

6.5.1 General

The port propeller has a brake to stop the propeller in a short time. The brake assembly is located in the port gear box and holds the gear box drive shaft.

6.5.2 Operation

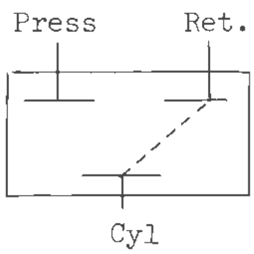
The system can be operated only when the aircraft is under the following conditions:

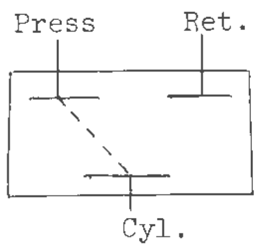
(1) Scissors relay Ground

(2) No. 1 eng. HPC Fuel off

If the propeller brake switch located at the left end of the auxiliary panel of the cockpit is set to "ON", the pressure port and cylinder port of the propeller are connected to each other.

Designed for solenoid operation, this control valve, operated by a solenoid, forms the following circuits:



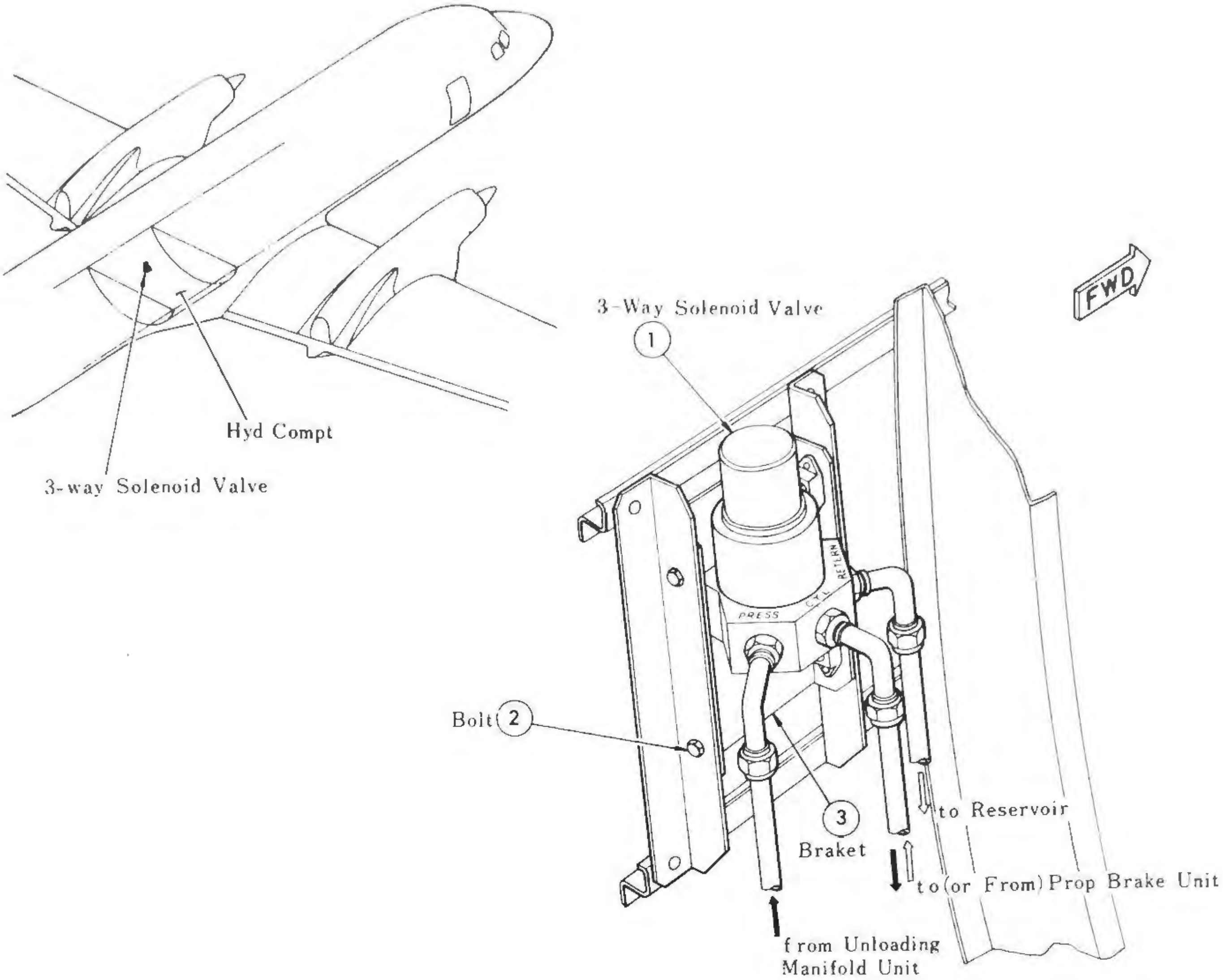


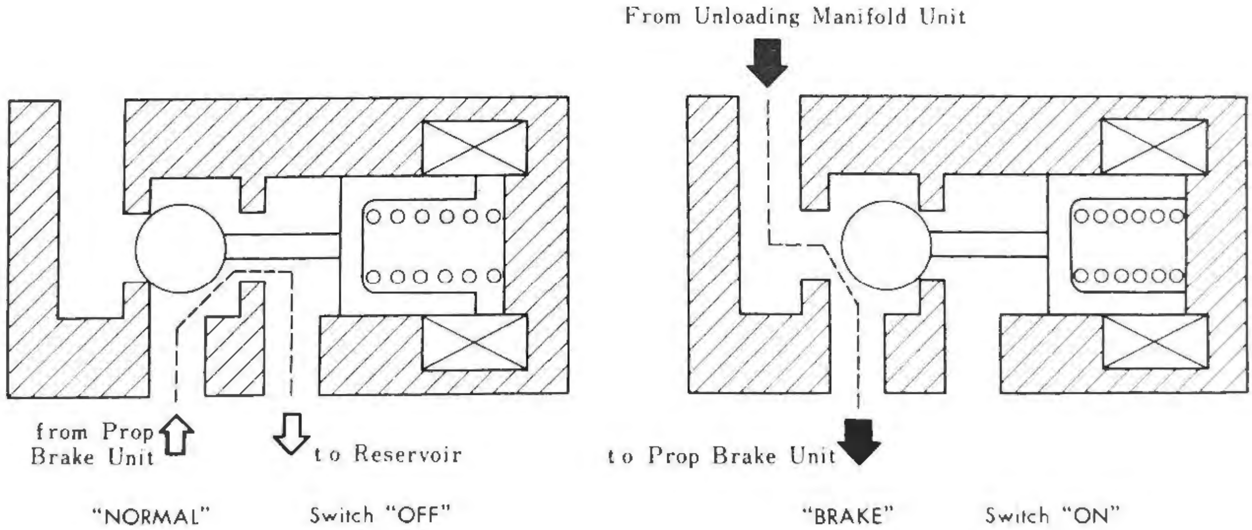
The hydraulic oil passed through the propeller brake solenoid valve is applied to the propeller brake unit of the gear box and controls the brake disc. This brake disc applies brakes on the propeller shaft through the gear box drive shaft.

6.5.3 Operation Check

(1) With the HPC lever at "Fuel Off" and the propeller brake switch at "ON", check that the propeller cannot be rotated by hand.

(2) With the HPC lever at "Fuel ON" and the propeller brake switch at "ON", check that the propeller can be rotated by hand.

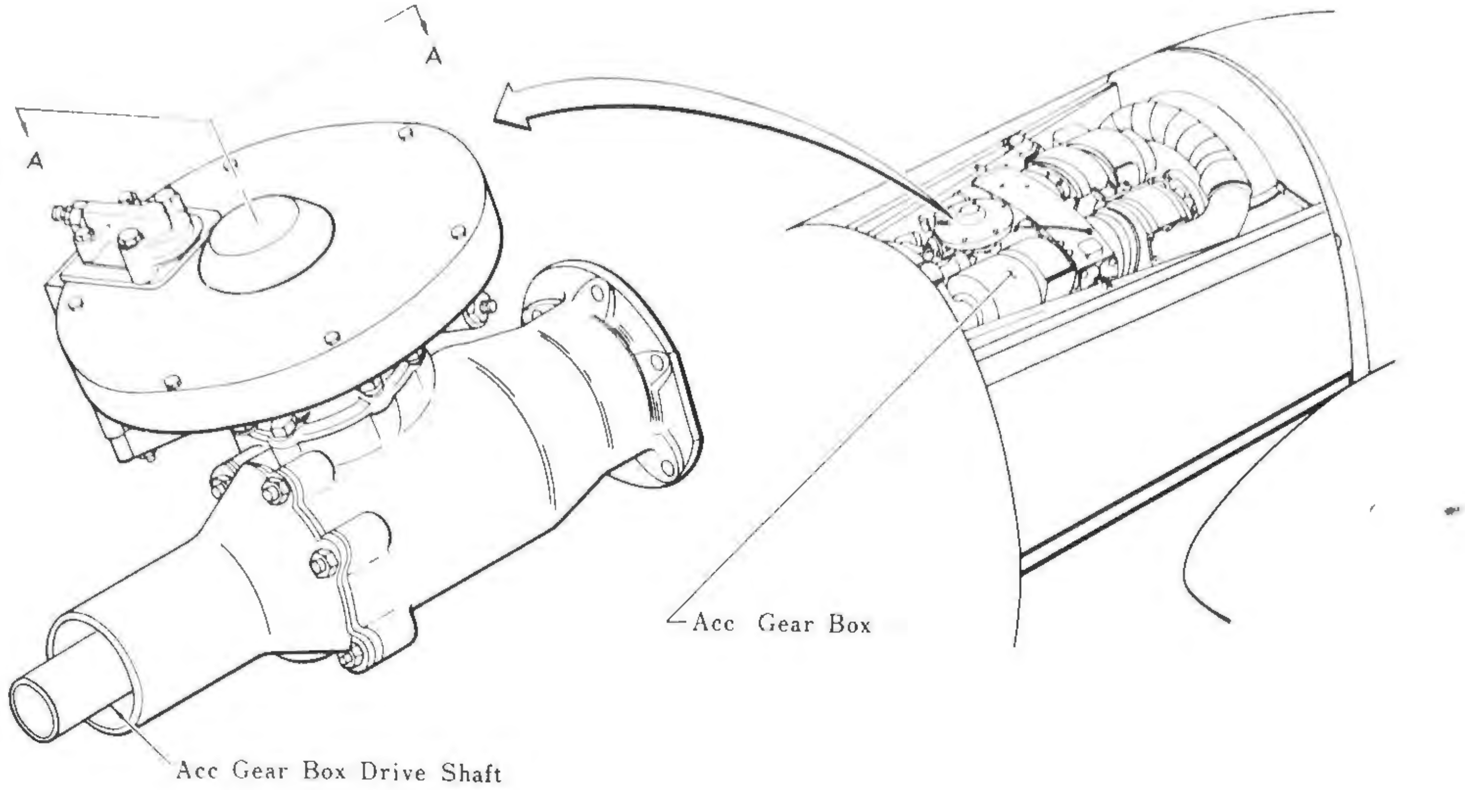


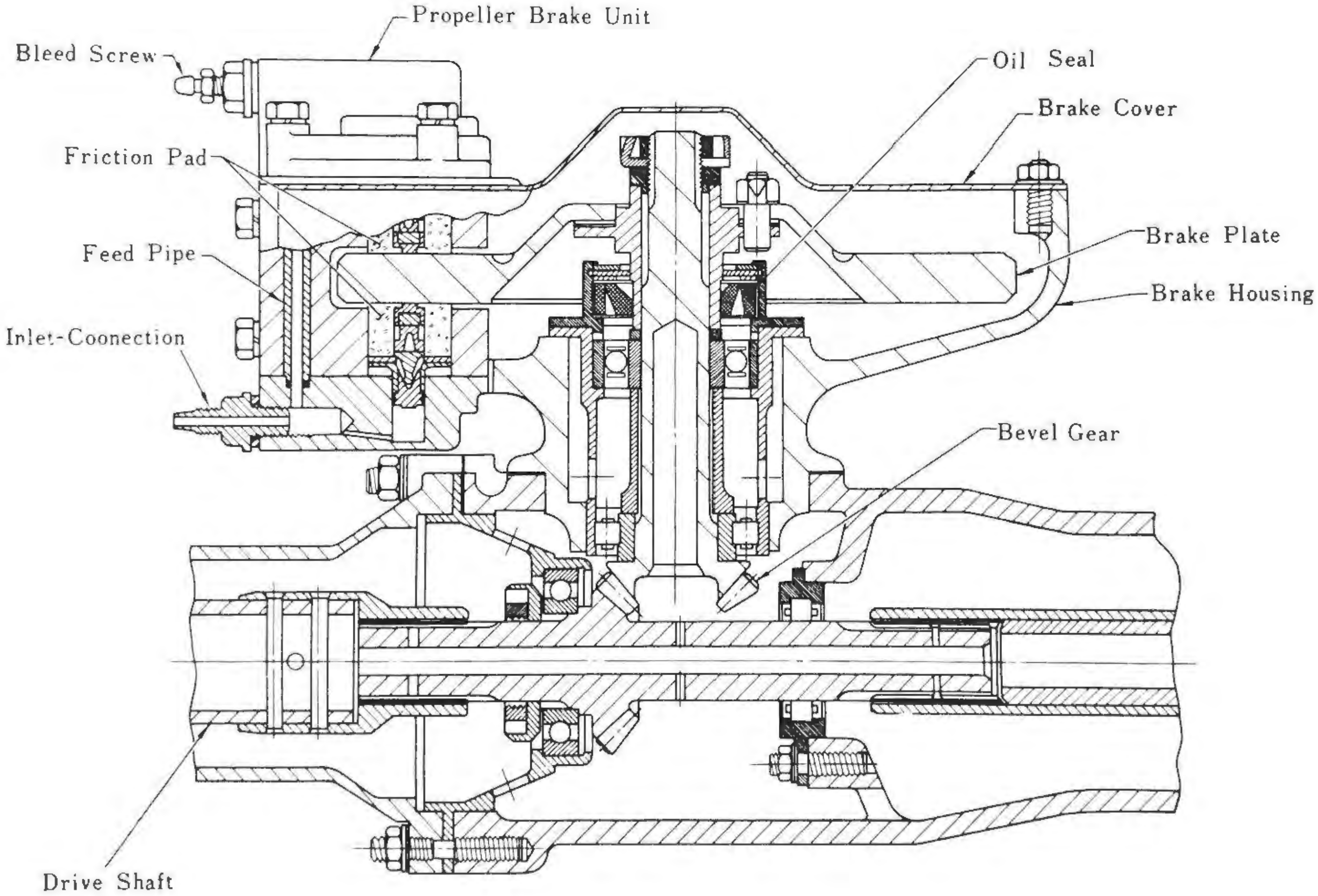


3-way Solenoid Valve Schematic Section View

Prop Brake Solenoil Valve Section View

Figure 6–16





Section A-A

Prop Brake Unit

Figure 6–17

6.6 Stairway System

6.6.1 General

The stairway system is operated hydraulically and controlled electrically. The stairway components include:

(1) Passenger entrance door and door actuating mechanism.

(2) Door lock mechanism

(3) Stairway assembly

(4) Platform assembly

(5) Hydraulic system

(6) Electrical system

(7) Emergency control system

The passenger entrance door is opened and closed as shown in Fig. 6-18 by a link mechanism installed under the floor. The door is actuated by a hydraulically operated cylinder. The door is locked in opened position by the stopper of the link mechanism located under the floor. In closed position, the door is locked and tightened to the aircraft by a latch rod built in the door. The latch rod of the door is actuated by a hydraulically operated door lock cylinder.

The stairway assembly is of three-fold type and is mounted on the attachment fitting under the floor (WP-850, BP-1000) by the bent head fitting located on the top of the stairway assembly. The stairway is retracted and lowered by a hydraulic cylinder (stairway actuating cylinder) mounted on the torque tube located at the end of the bent head fitting. The stairway has a hinge under the floor.

When it is retracted, it is erected in three folds so that a portion of the aisle floor plate must move together with the stairway. The floor plate which moves with the stairway is the platform assembly. In up position, the stairway is locked by a mechanical lock mechanism, but has no lock mechanism in down position.

The stairway is actuated by hydraulic oil supplied by the emergency hydraulic pump. The hydraulic circuit is connected to the landing gear down line.

The stairway can be controlled from both inside and outside the aircraft.

Inside the aircraft, the control switches and indicating lights are located on the forward stewardess panel. Outside the aircraft, they are located at the external power supply connection panel on the nose end of the fuselage.

A. Forward stewardess panel

(A) Mechanical lock handle

(B) Stairway selector switch

(C) Indicator lights

Emergency hydraulic pump .... Amber
Prop brake .... Green
Limit switch failure warning .... Red

B. External power supply connection panel

(A) Stairway selector switch

(B) Indicator light

Emergency hydraulic pump .... Amber

Power supply for the electrical system is taken from the DC emergency bus. The control circuit is formed only when the aircraft is on the ground.

When there is trouble in the hydraulic and electrical systems, the stairway can be brought down by an emergency control system. Unlock the door by the manual handle, push the door open by hand, and push the stairway down.

6.6.2 Operation of Stairway

The aircraft must be in the following conditions.

A. Scissors relay .... Ground

B. L/G selector lever .... Down

C. HPC lever .... Fuel off

D. Prop brake .... ON

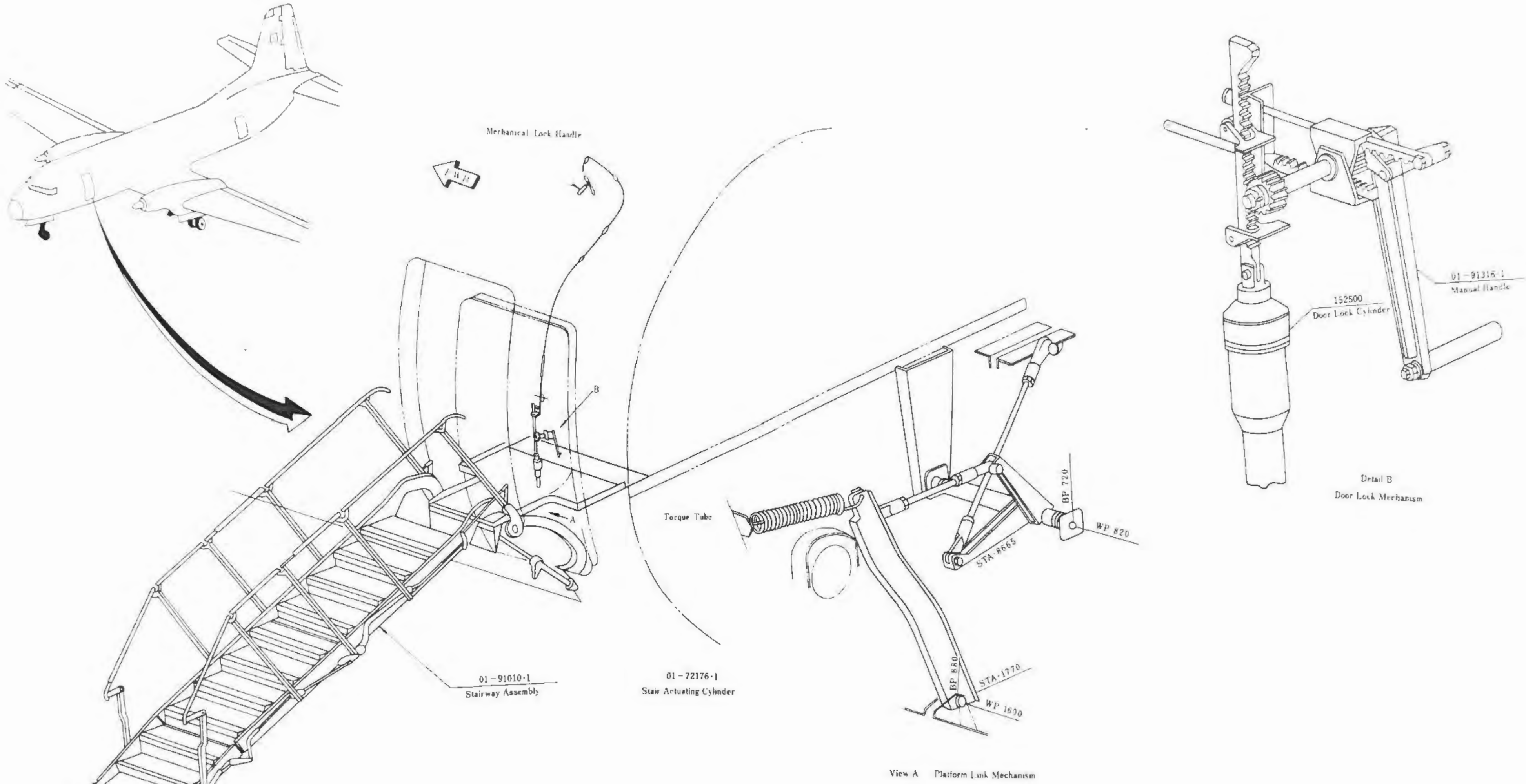
(Otherwise, the electrical and hydraulic circuits are not formed.)

(1) Stairway Down

Operation from inside the aircraft

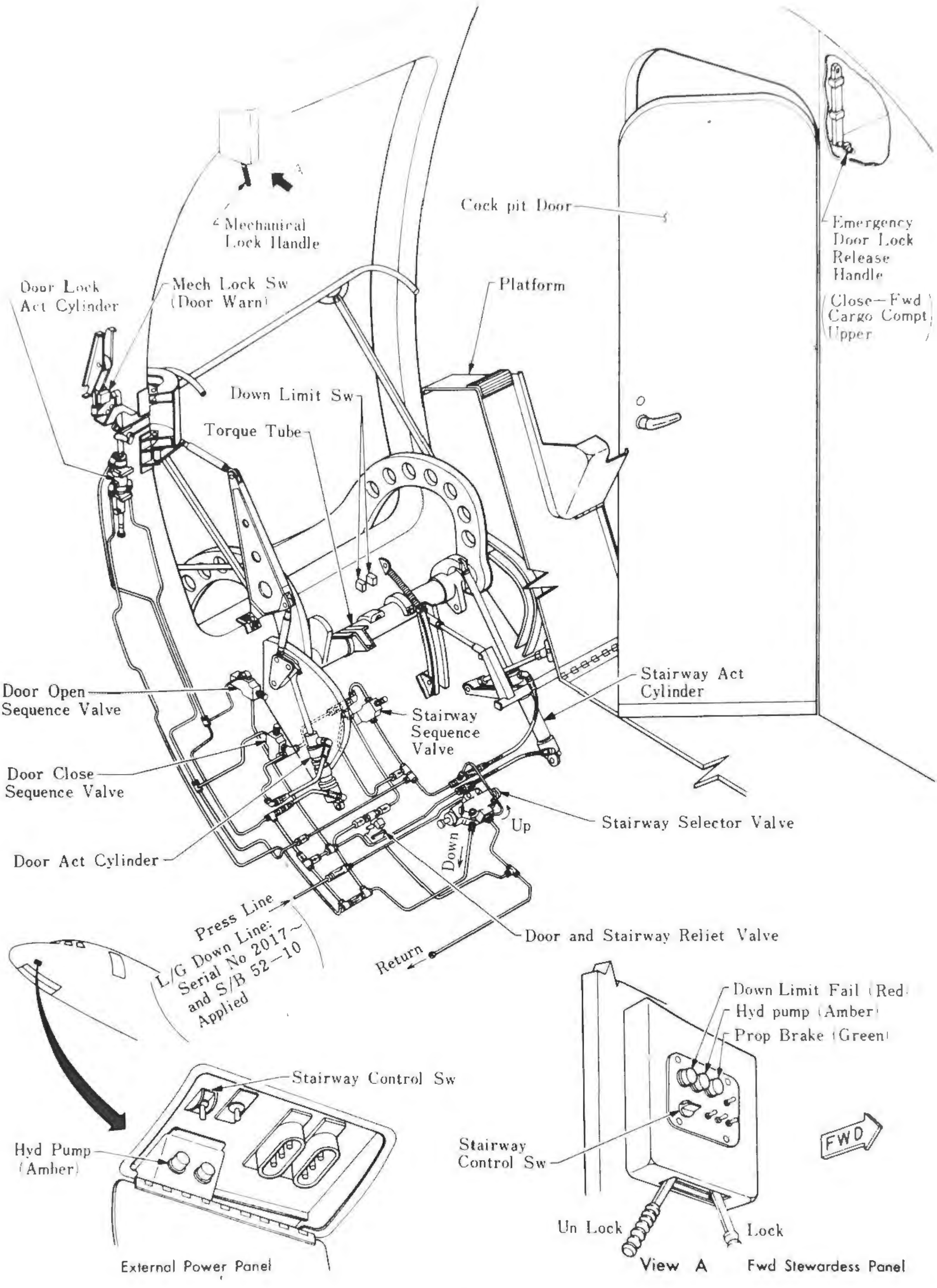
(A) If the mechanical lock handle is set to "Unlock", the door lock limit switch is set to ON and the door open warning light (amber) of the cockpit comes on.

(B) If the stairway selector switch (momentary switch) is set to "Down", the emergency hydraulic pump relay is energized, the



Arrangement of Air Stair Mechanism

Figure 6-18



Stairway Actuating System Arrangement

Figure 6–19

pump comes into action, and the indicator lights (amber) of the control panel and the cockpit come on.
The selector valve of the hydraulic circuit is a solenoid valve. The down side is energized and hydraulic oil flows toward the down line. The hydraulic oil is fed to the door lock cylinder and releases the latch rod of the door lock. Thereafter, it expands the door actuating cylinder and opens the door outward. The door actuating cylinder, at its stroke end, mechanically opens the path of the door open sequence valve located under the floor and extends the stairway actuating cylinder to bring the stairway down. The stairway begins to go down, sets the No. 1 down limit switch to "OFF" at 20° before its stroke end, de-energizes the solenoid of the stairway selector valve, and returns the solenoid to the neutral position. For this reason, the stairway goes down with its own weight. At this point, the emergency hydraulic pump indicator lights of the control panel and the cockpit go out.
The No. 2 down limit switch is provided to indicate that there is trouble in the No. 1 down limit switch. If the red down limit switch failure light comes on, the selector switch must be turned OFF.

Operation from outside the aircraft

Operation from outside the aircraft can be performed by setting the mechanical lock handle of the forward stewardess panel to the Unlock position. The operation is the same as the operation from inside the aircraft.

(2) Stairway Up

Operation fron inside the aircraft

(A) Mechanical lock handle "Unlock"

Then, the door warning light (amber) of the cockpit comes on.

(B) Stairway selector switch "Up"

Then, the emergency hydraulic pump begins to rotate, and the indicator lights of the control panel and the cockpit come on.

The up side of the stairway selector valve of the hydraulic circuit is energized and hydraulic oil enters the up side. The stairway begins to go up. At 15° of the up stroke, the No. 2 down limit switch is set to "off". At 20°, the No. 1 down limit switch is set to ON. At the end of the up stroke, the stairway mechanically opens the up sequence valve and feeds hydraulic oil to the door actuating cylinder. At the same time, the stairway is locked by a lock mechanism. The door actuating cylinder is retracted, closing the door. At the stroke end, it mechanically opens the door close sequence valve and feeds hydraulic oil to the door lock cylinder. In the retracted position, the door lock cylinder holds the door against the aircraft and locks the

latch rod.

If the door is locked by the door lock cylinder, the door lock limit switch is set to OFF at the stroke end and the emergency, stopping the hydraulic pump. At the same time, the selector valve is returned to the neutral position.

Then, the indicator lights (amber) of the control panel and the cockpit go out.

Next, the stairway selector switch is set to "OFF".

(C) Mechanical handle "Lock"

Then, the door open warning indicator light (amber) of the cockpit goes out.

Operation from outside the aircraft

The operation is the same as that from inside the aircraft. The only difference is that the last mechanical lock handle cannot be locked.

6.6.3 Component Mechanisms

(1) Door and Door Mounting

The passenger entrance door has no pressure lock and open lock mechanisms employed for the other doors.

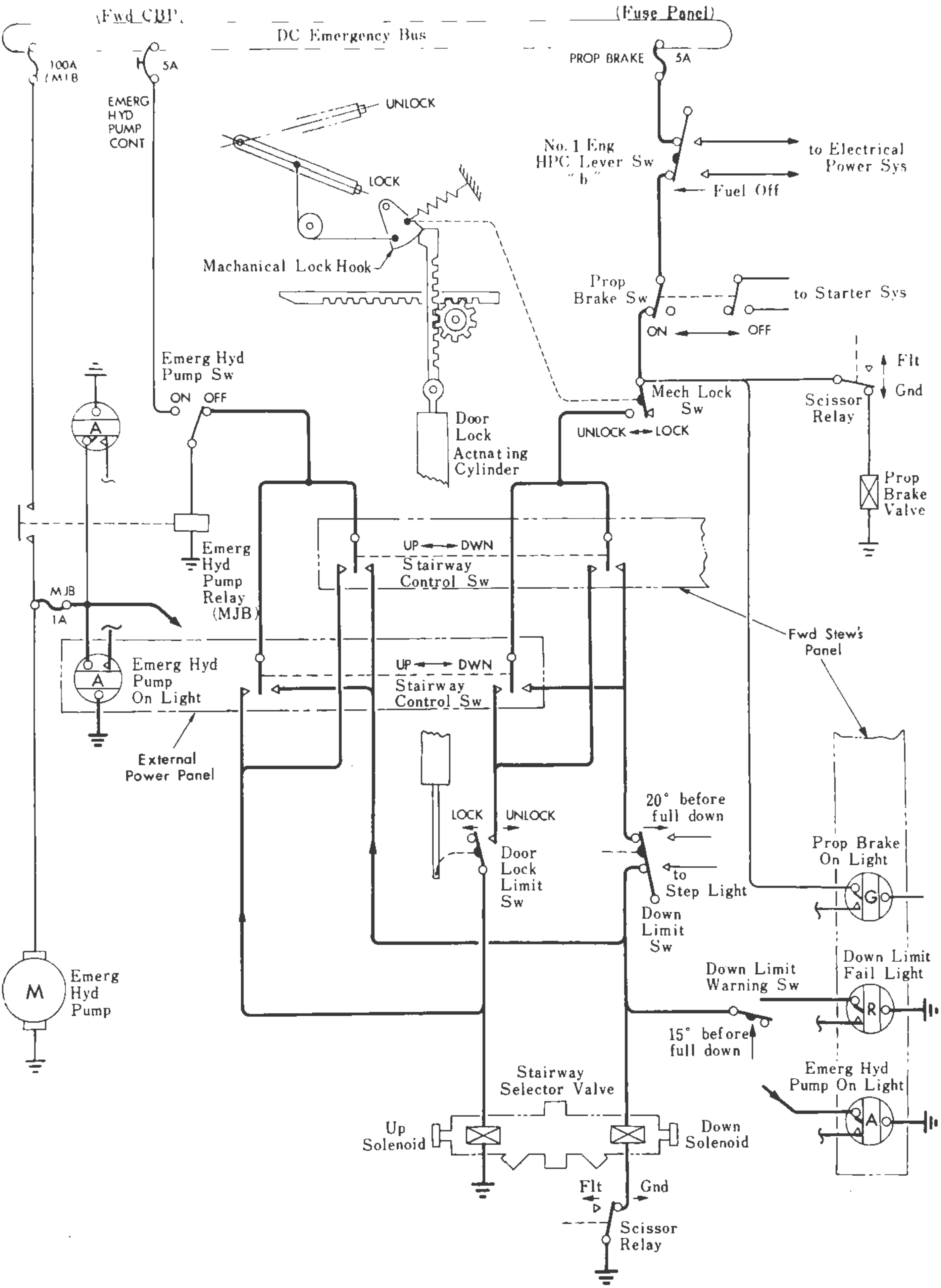
Each peripheral side of the door is provided with a roller to facilitate opening and closing the door. On the center surface (inside) of the door, a hinge is located which is mounted on the aircraft by a large curved arm. On the lower surface of the door, a door actuating mechanism lever is located.

(2) Door Lock Mechanism

The passenger entrance door is locked in closed position by a latch rod as in the case of the other doors. There are 10 latch rods in total.

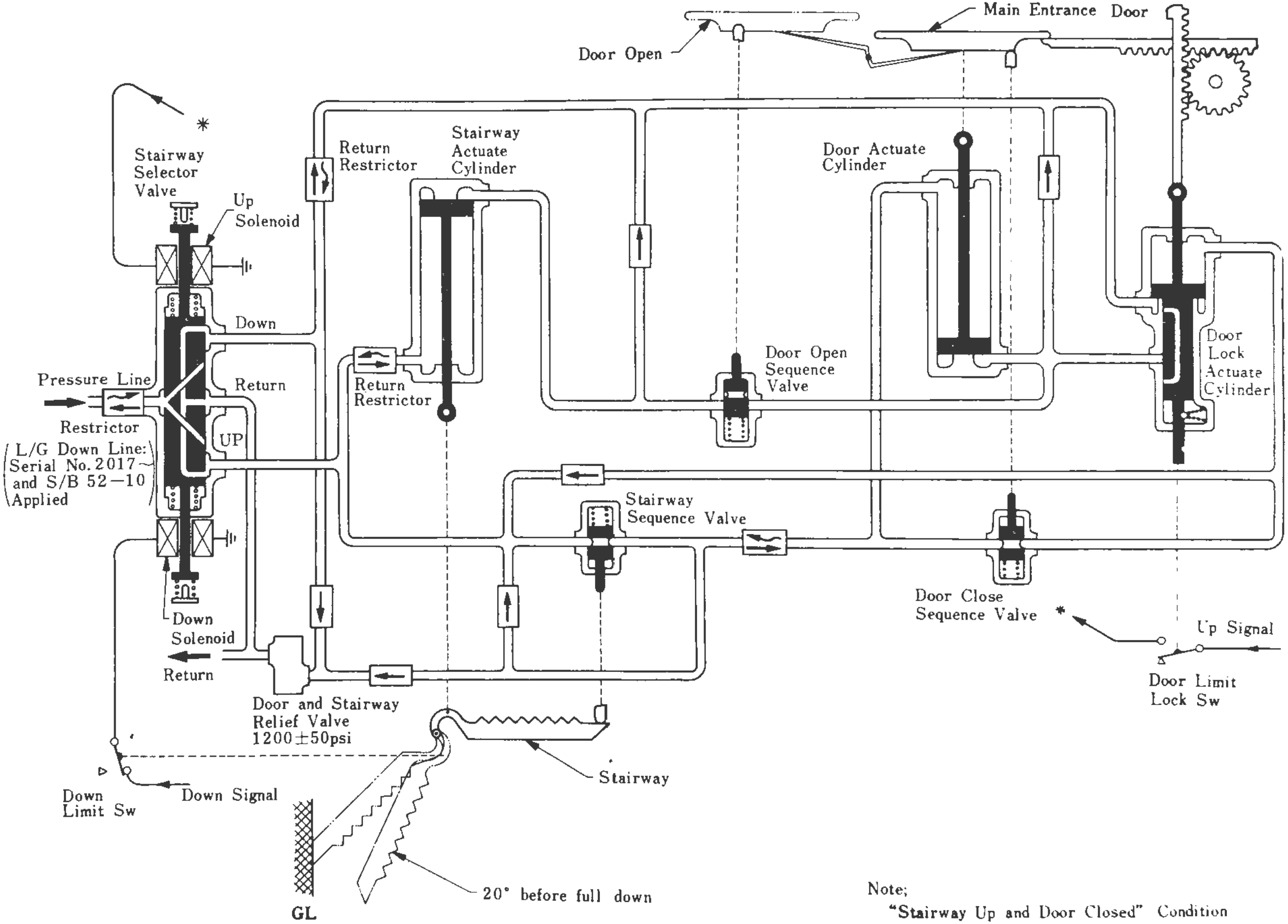
The aircraft is provided with, a hydraulically operated door lock cylinder. This cylinder rod is provided with a rack. Two push-pull rods, which are moved by a pinion system engaging with the rack, extend toward the door. One is provided for locking the door, while the other is for unlocking the door.

The door is provided with a push-pull rod having a rack which is pushed by the push-pull rods on the aircraft. The pinion, which is engaged with the rack, rotates and the crank mechanism coaxial with this rotates the torque tube which moves the latch rod and performs lock-unlock operation.



Stairway Control Electric Schematic

Figure 6–20



Stairway Hydraulic Schematic

Figure 6-21

Note;
"Stairway Up and Door Closed" Condition

(3) Door Actuating Mechanism

The door is opened and closed by a hydraulically operated door actuating cylinder located under the floor. For details on the link mechansim and the path of the travelling door, refer to Fig. 6-23.

The door is locked in closed position in such a way that the point "k" of the underfloor lever will over-center the line linking the lever mounting hinge μ and the point μ . Furthermore, the lever is provided with an assist spring to prevent the door from closing inadvertently.

The door is locked in the opened position by the latch rod of the door.

Mechanical lock handle

To prevent the door lock cylinder from being unlocked inadvertently, a mechanical lock is located on the upper part of the door lock cylinder.

Furthermore, a mechanical lock which locks the stairway in the up position is located under the floor, both being actuated in linked motion. These mechanical locks are operated by the mechanical lock handle.

The mechanical lock mechanism has limit switches. These limit switches are important elements which constitute the electrical control system of the stairway.

(4) Stairway Assembly

The stairway assembly consists of a stairway proper, hand rail, link mechanism and guide rail.

The stairway proper has 10 steps, measuring 3,600mm in full length and approx. 560mm wide. The angle the stairway makes with the ground surface when brought down is 40° at the maximum. The stairway is of three-fold type and is separable into the upper, middle and lower assemblies. These sub-assemblies are coupled with one another by hinge bolts below the stairway. On the upper surface of the stairway, stop bolts are located for adjustment when the stairway is extended. For each step, an illuminating light is provided. At the bottom of the lower sub-assembly, rollers are located. A torque tube is mounted with bolts on the bent head fitting of the upper sub-assembly of the stairway proper. The stairway proper is mounted on the aircraft by fastening the aircraft side mount support base and the torque tube with hinge bolts in two places. An oilless bearing is built in the rotary shaft. The stairway actuating cylinder, stairway down limit switch (No. 1 and No. 2) operating cam, up sequence valve and operating arm are mounted on the torque tube. The stairway up lock is engaged hydraulically. The stoppers at the stroke ends of the stairway are located at:

Down side	Guide rail
Up side	Under the aircraft floor

The hand rail and link mechanism are employed to fold the stairway when it is operated. The hand rail support posts are mounted on the stairway proper and are provided with oilless bearings to permit free rotation round the mounted points. These are operated by rollers at the bottom end of the first support post assembly. When the stairway proper is driven by the stairway actuating cylinder, the rollers move along the guide rail under the floor of the aircraft. As a result, the stairway proper and the hand rails are folded into three by their link mechanism.

The step lights are controlled by the No. 1 down limit switch. If the entrance light switch on the forward stewardess panel is set to ON, the light comes on when the No. 1 down limit switch is cut off (emergency hydraulic pump stopped) at 20° before the fully down position.

(5) Emergency Control System

This is a system designed to lower the stairway manually when there is trouble in the hydraulic electrical system. The system, however, cannot be used to bring the stairway up.

Rotate by the manual handle the gear rotated by the rack of the door lock cylinder and release the door lock. This manual handle is usually accommodated in the upper shelf of the forward cargo compartment. Release the lock, push the door open by hand, and lower the stairway proper by hand.

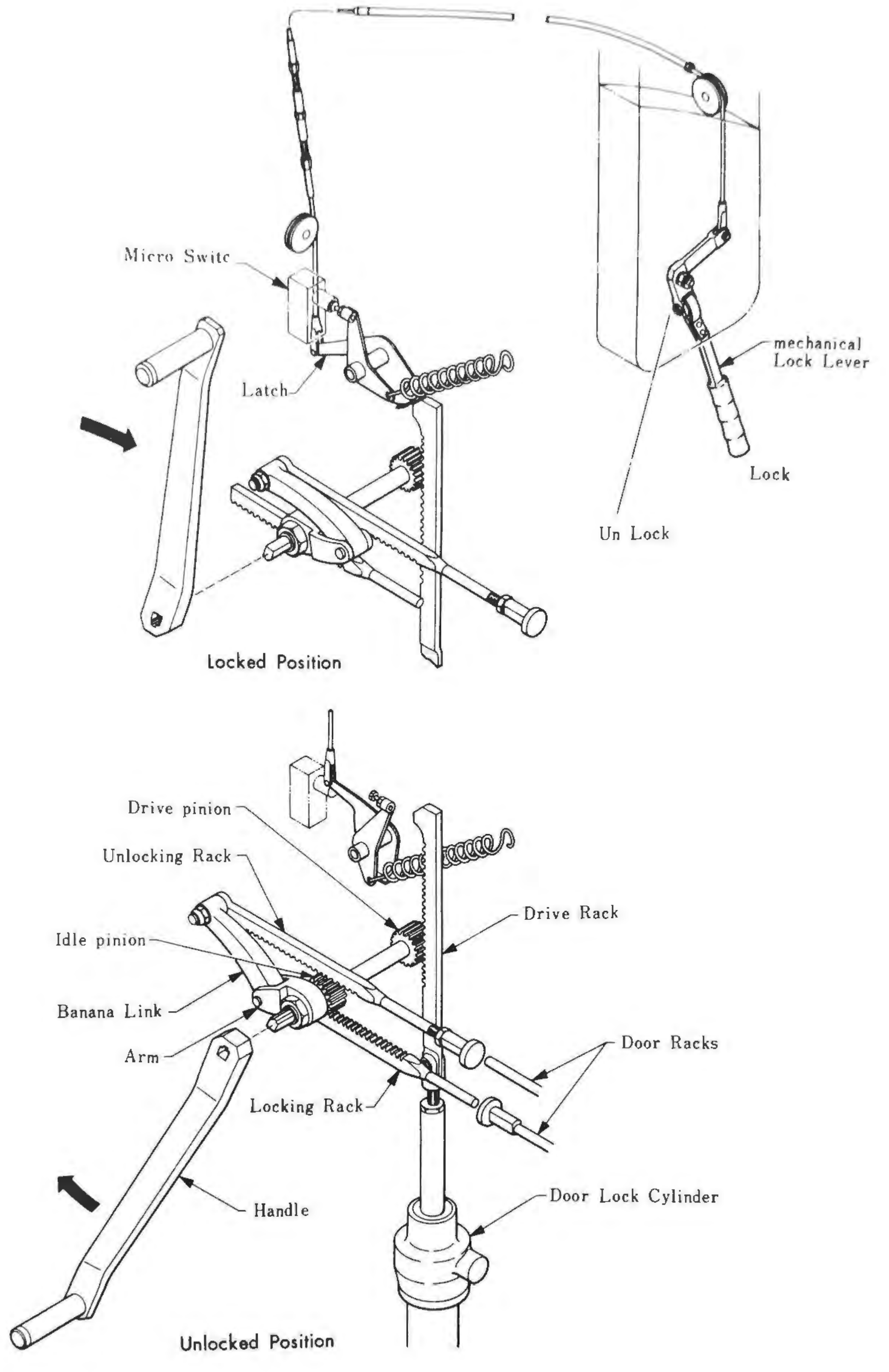
(6) Platform Assembly

This forms the passenger entrance aisle when the stairway is brought down. The platform link mechanism is kept in contact with the torque tube at all times by a spring so that the assembly is actuated along with the motion of the torque tube of the stairway proper.

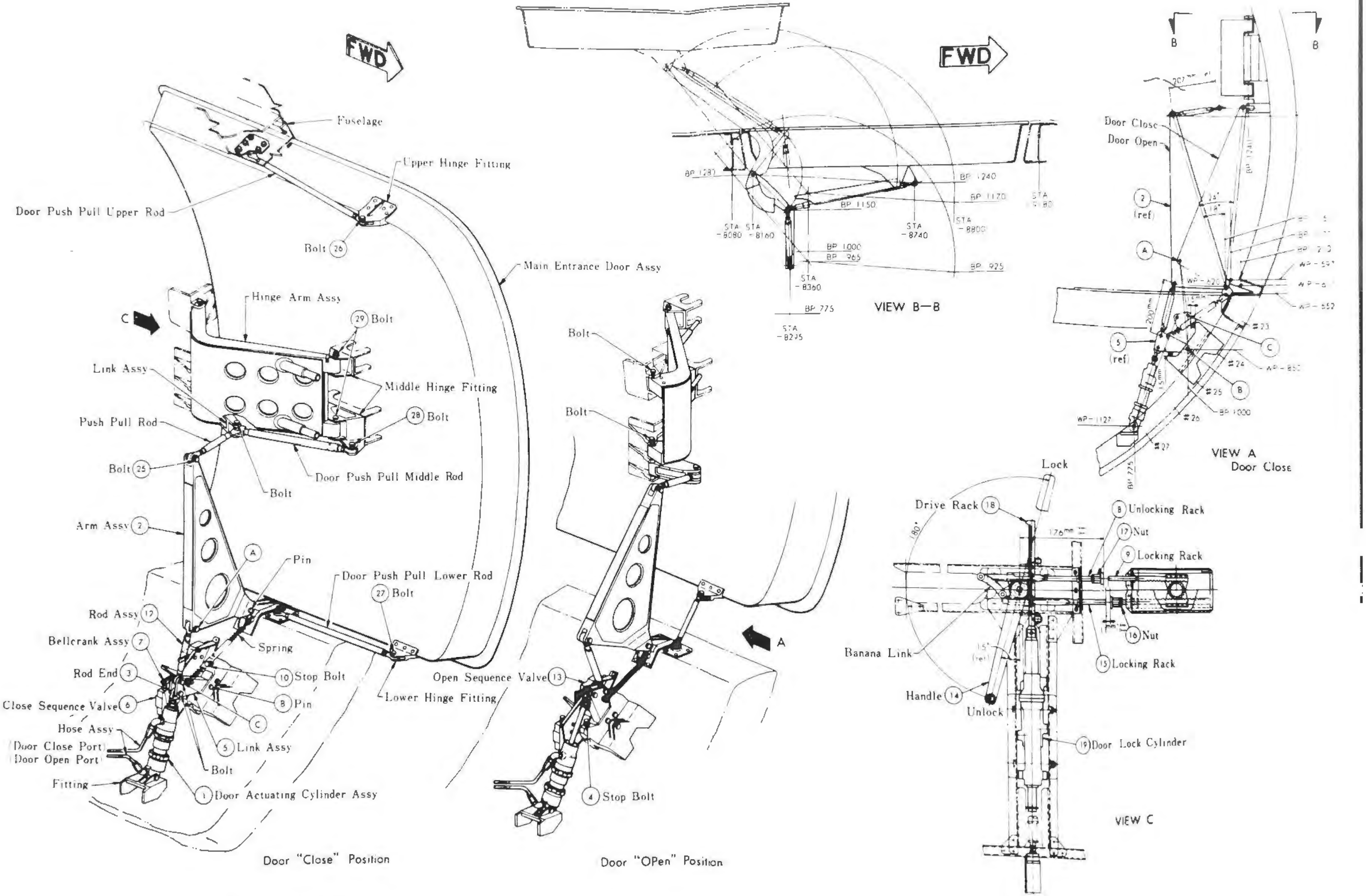
6.6.4 Door Warning System

When the door is opened, the door opening warning light of the copilot's side panel of the cockpit comes on.

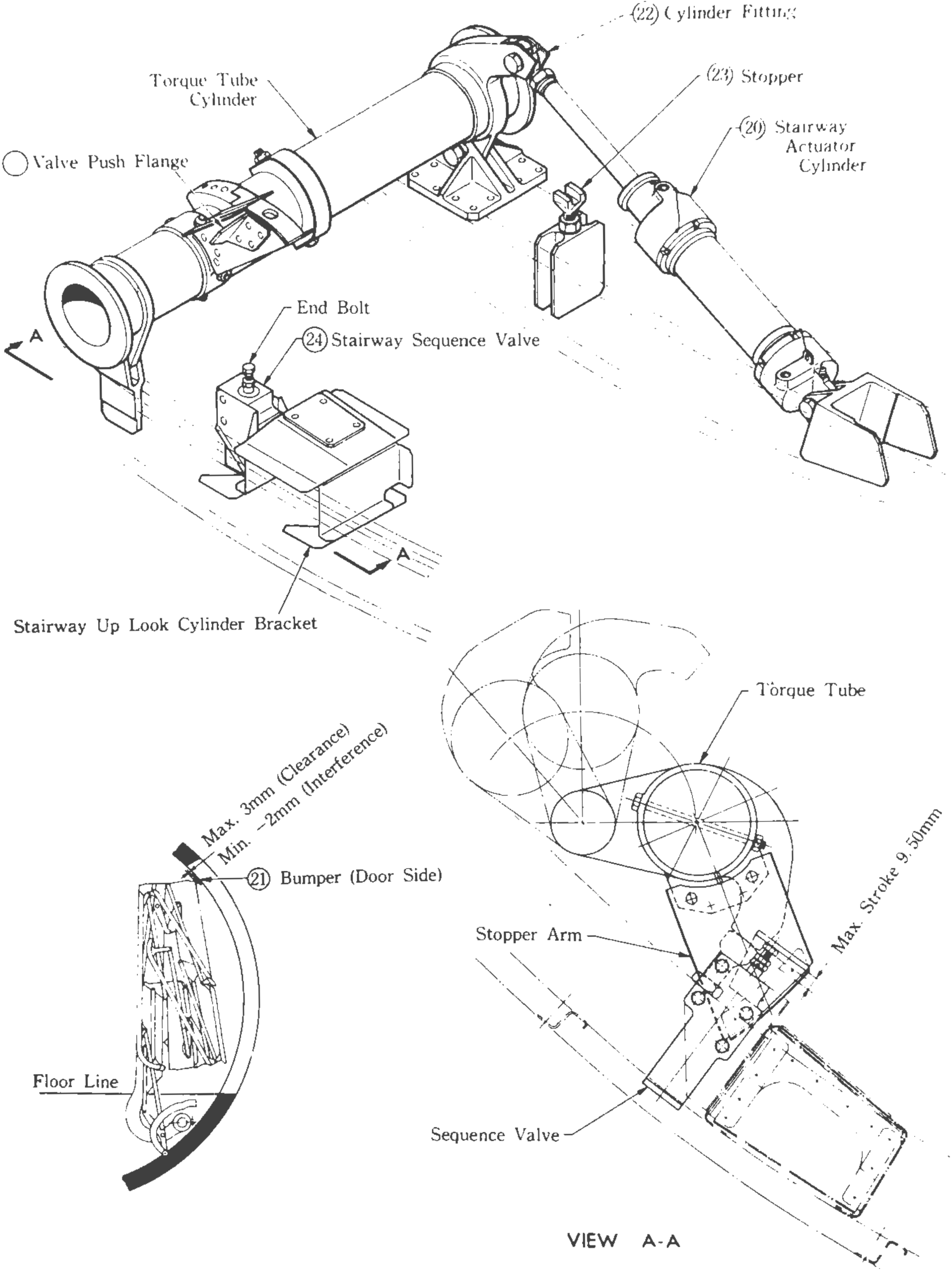
This system consists of under-floor door and above-floor door systems. The end of the latch rod of each door actuates a micro switch.



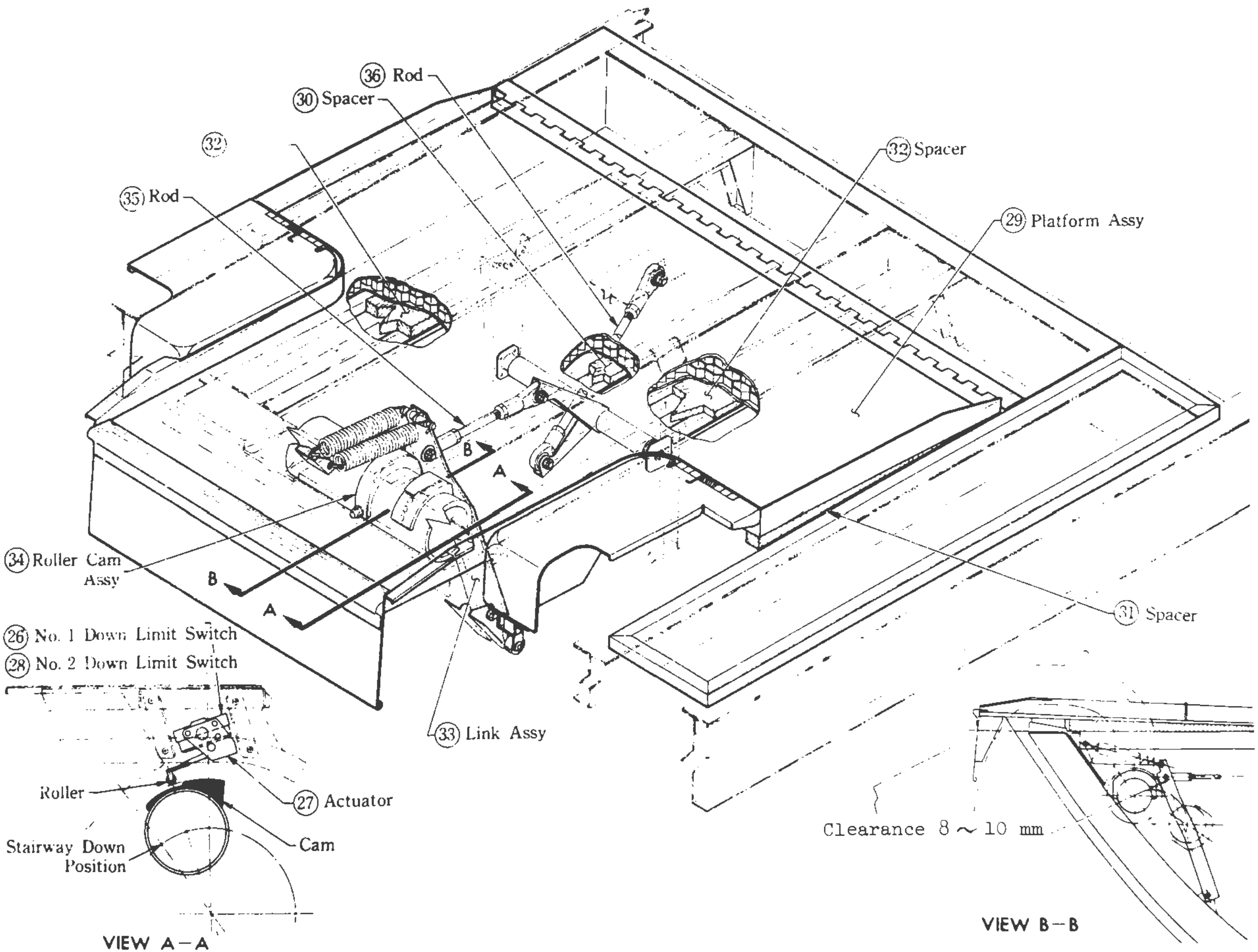
Door Locking Mechanism and Mechanical Lock
Figure 6–22



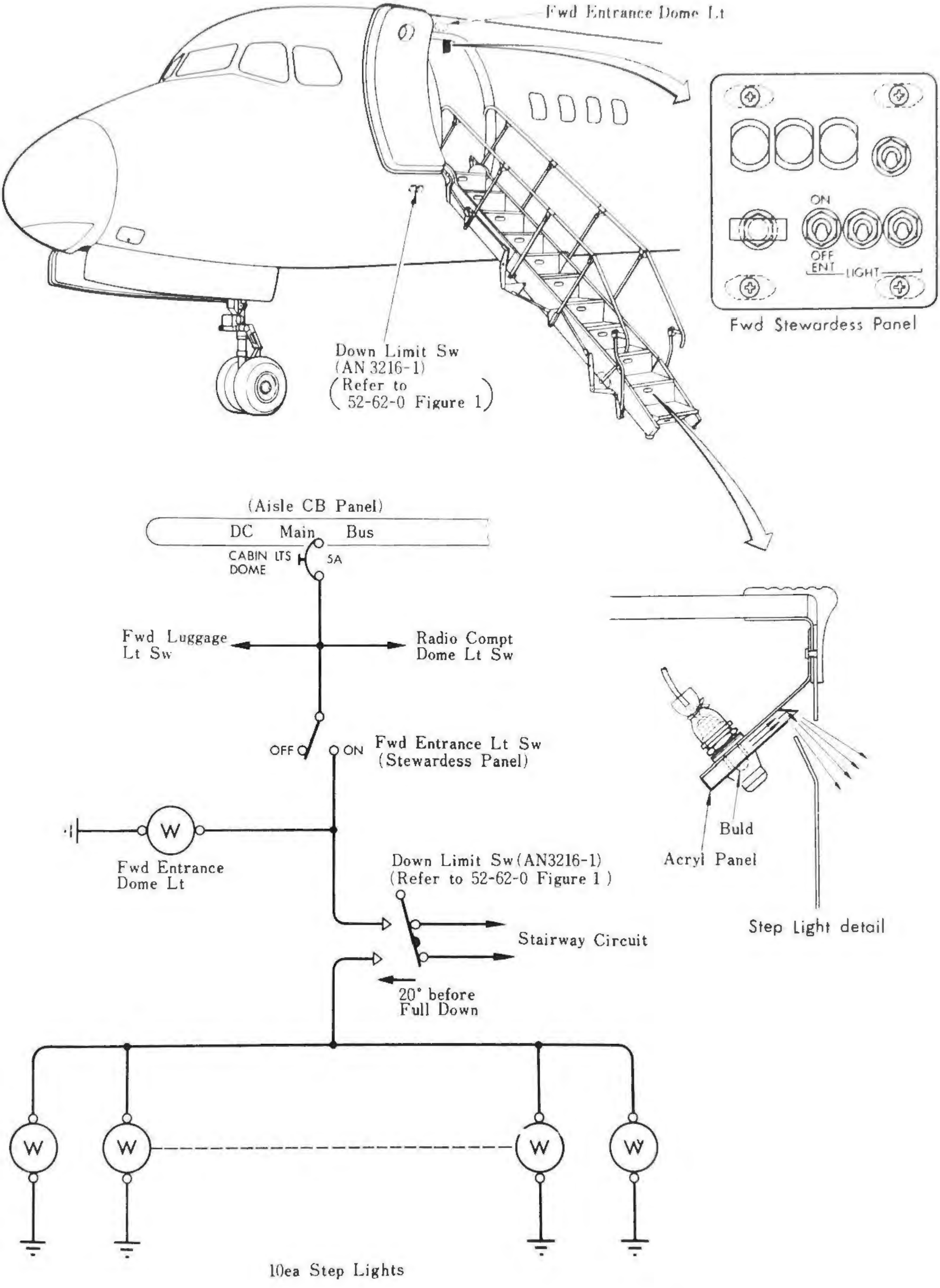
Door Opening Mechanism
Figure 6-23



Stairway Assy-Adjustment
Figure 6-23A

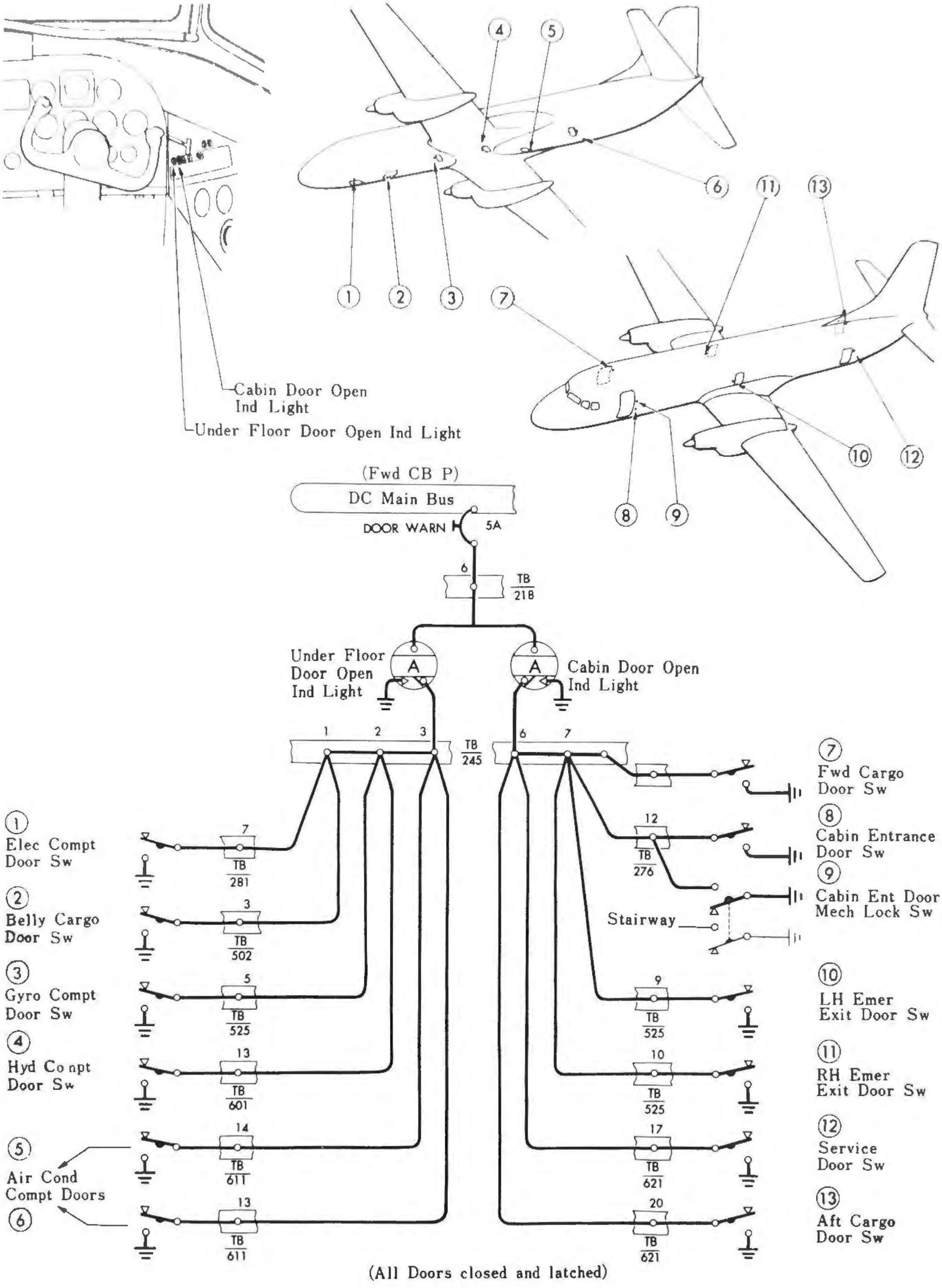


Platform Assy Adjustment
Figure 6-23B



Stairway Lighting System

Figure 6–24



Door Warning System

Figure 6-25

Chapter 7 FLIGHT CONTROL SYSTEM

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Chapter 7 Flight Control System

7.1 General

7.1.1 Principal Flight Control System

The aileron is provided with a spring tab and a trim tab, the rudder is provided with a tab which can be used as a spring tab and a trim tab and the rudder is provided with a balance tab and a trim tab.

All the control surfaces of dual control type are controlled manually and control wheels, columns and pedals are provided for the pilot and the co-pilot. These controllers and the control surfaces are connected with cables and push-pull rods. On the center pedestal are provided control knobs and indicators for each trim, the trim angles being shown on the indicators.

7.1.2 Flap

The flap of Fowler type is actuated hydraulically. The flap control is conducted electrically by a flap control switch which is located on the center pedestal.

The flap is provided with an asymmetry protection unit. If the angles of the L.H. and the R.H. flaps differ by 1° to 3.5°, for some reason or other the electric control circuit is interrupted, stopping the flaps automatically to stop the agravation of the asymmetry.

7.1.3 Angles of Control Surfaces

Control Surface		Position	Angle
Aileron	Aileron	Up Down	$24^\circ \pm 1^\circ$ $15^\circ \pm 1^\circ$
Aileron	Spring Tab	Up Down	$18^\circ \pm 0.5^\circ$ $10^\circ \pm 0.5^\circ$
Aileron	Trim Tab	Up Down	$21^\circ \pm 0.5^\circ$ $21^\circ \pm 0.5^\circ$
Rudder	Rudder	L.H. R.H.	$22^\circ \pm 0.5^\circ$ $22^\circ \pm 0.5^\circ$
Rudder	Spring Tab	L.H. R.H.	$21^\circ \pm 0.5^\circ$ $21^\circ \pm 0.5^\circ$
Rudder	Trim Tab	L.H. R.H.	$12.5^\circ \pm 0.5^\circ$ $12.5^\circ \pm 0.5^\circ$
Elevator	Elevator	Up Down	$27^\circ \pm 0.5^\circ$ $13^\circ \pm 0.5^\circ$
Elevator	Balance Tab	Up Down	5.9° 12.2°
Elevator	Trim Tab	Up Down	$10^\circ \pm 0.5^\circ$ $15^\circ \pm 0.5^\circ$

Flap Angle $35^\circ {}^{+0^\circ}_{-1^\circ}$

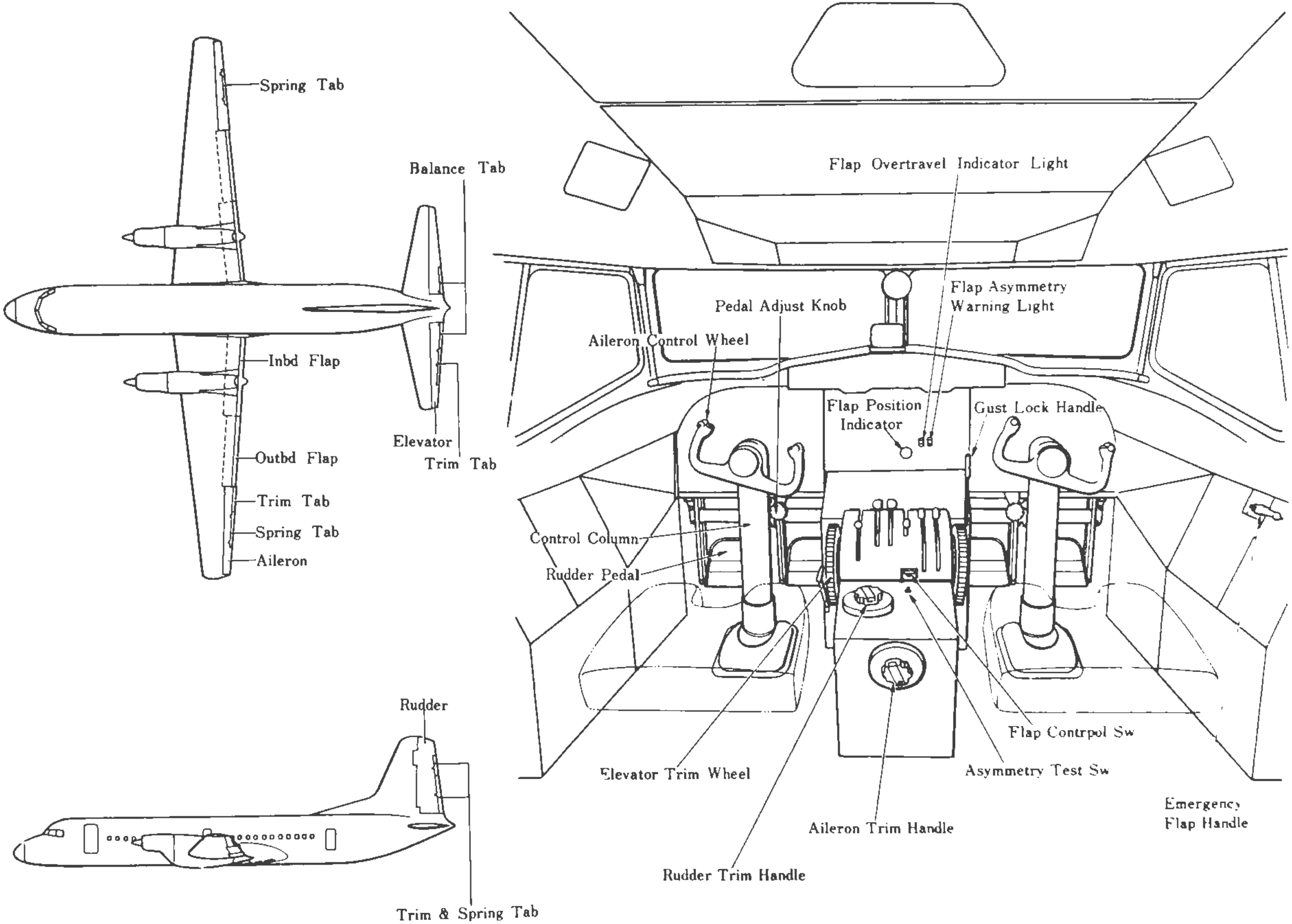
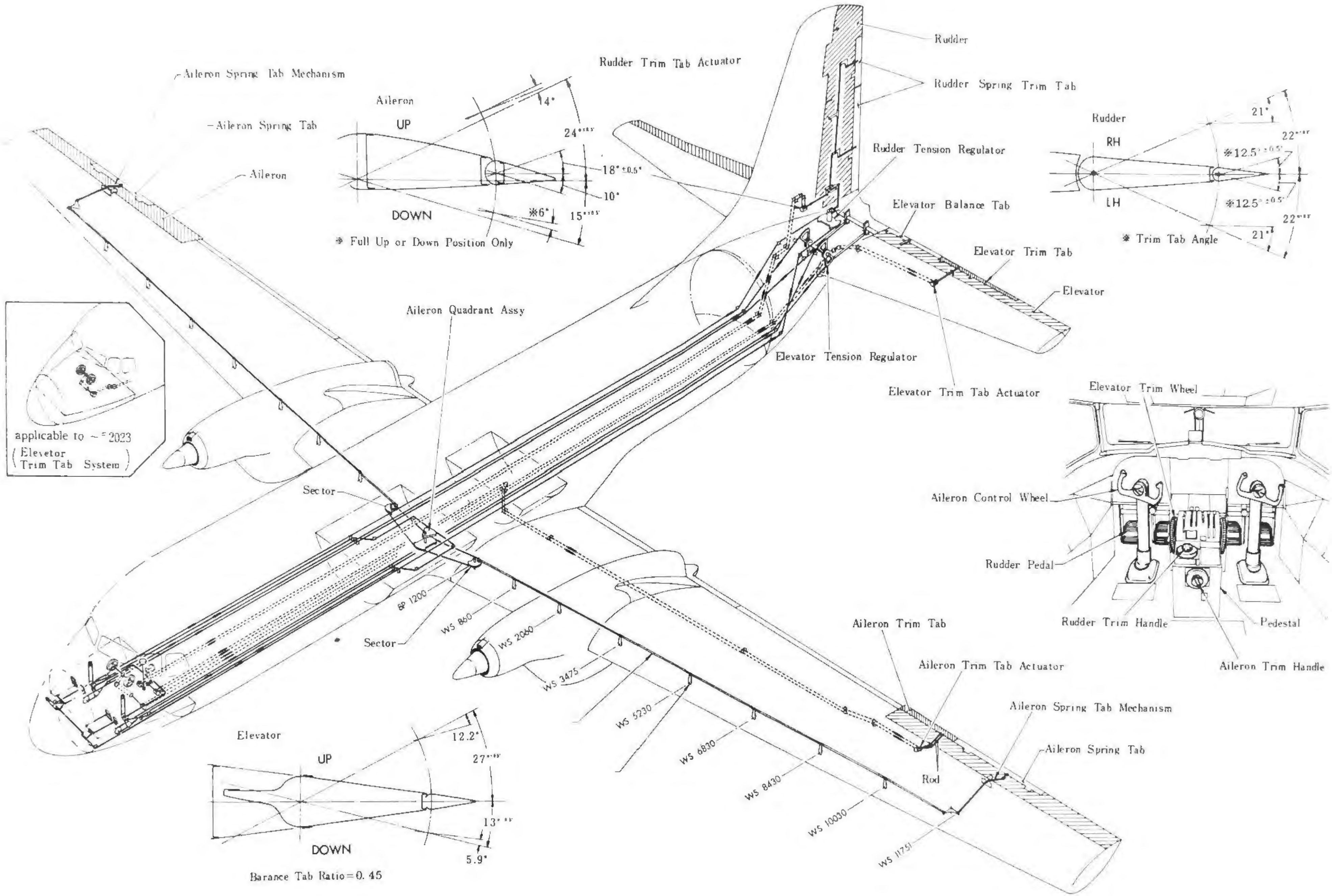


Figure 7-1
Flight Control



Fight Control System
Figure 7-2

7.1.4 Gust Lock

The three flight control surfaces are provided with the gust lock units, fixing them in the neutral position while the aircraft is parked to avoid damage to them. Between the gust lock lever and the low stop lever (power control lever) is provided an interlocking mechanism which prevents accidents due to misoperation in flight.

<u>NOTE</u>: For the interlocking mechanism, see Chapter 5, POWER PLANT.

7.1.5 Control Cable and Cable Tension Regulator

In the control system of the rudder and the elevator running through the entire fuselage are provided the cable tension regulators which maintain the cable tensions at certain values, independent of the variation of the outside air temperature.

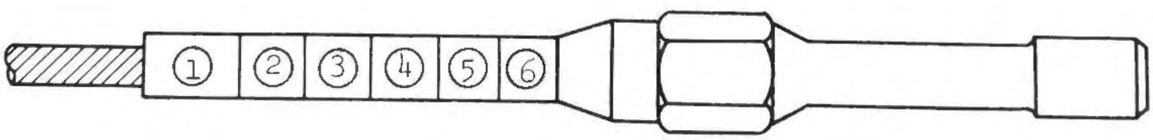
The aileron control system is not provided with the cable tension regulators.

The control cable is made of carbon steel (MIL-C-1511).
The sizes in use are as follows:

Principal control system	3/16 in. dia.
Trim systems	3/32 in. dia.

The fuselage pressure bulkheads through which the control cables pass are sealed for air tightness.

For cable identification, identification tapes are wound around the cable terminals so that the cables can be identified by the position, color and arrangement of the tapes. The relationship of the cables and the identification tapes is shown below.



System		Function	(1)	(2) (3)	(4)	(5) (6)
Principal Flight Control System	Aileron	Wheel, R/H rotation	Violet	Yellow	Violet	-
		Wheel, L/H rotation	"	"	"	Brown
	Rudder	R/H pedal, pushed	"	Green	"	-
		L/H pedal, pushed	"	"	"	Brown
	Elevator	Column, pulled	"	Red	"	-
		Column, pushed	"	"	"	Brown
Trim System	Aileron	Knob, R/H rotation	Blue	Yellow	Blue	-
		Knob, L/H rotation	"	"	"	Brown
	Rudder	Knob,R/H rotation	"	Green	"	-
		Knob,L/H rotation	"	"	"	Brown
	Elevator	Knob,rearward rotation	"	Red	"	-
		Knob,forward rotation	"	"	"	Brown
Auto Pilot System	Aileron	Wheel, R/H rotation	White	Yellow	White	-
		Wheel, L/H rotation	"	"	"	Brown
	Rudder	R/H pedal, pushed	"	Green	"	-
		L/H pedal, pushed	"	"	"	Brown
	Elevator	Column, pulled	"	Red	"	-
		Column, pushed	"	"	"	Brown
	Elevator Trim	Knob, rearward rotation	"	"	Blue	-
		Knob, forward rotation	"	"	"	Brown

System		Function	(1)	(2)	(3)	(4)	(5)	(6)
Gust Lock	Aileron	Lock	Orange	Yellow		Orange	-	
		Unlock	"	"		"	Brown	
	Rudder	Lock	"	Green		"	-	
		Unlock	"	"		"	Brown	
	Elevator	Lock	"	Red		"	-	
		Unlock	"	"		"	Brown	
	Where 3 control surfaces or 2 control surfaces are joined together	Lock	Orange				-	
		Unlock	"				Brown	
Flap	Emer flap	Up	Blue		Yellow		-	
		Down	"		"		Brown	
Hydraulic Control System	Nose steering	Wheel, R/H rotation	Yellow				-	
		Wheel, L/H rotation	"				Brown	
	By-pass V. (Depress V)	Normal	Blue				-	
		By-pass (Depress)	"				Brown	
	L/G control V.	Up	White				-	
		Down	"				Brown	
	Normal brake	On	Green				-	
		Off	"				Brown	
Power Plant Control System	H.P.C.	H.S.W.	Green	White		Green	-	
		Off	"	"		"	Brown	
	Throttle	R.P.M. Increase	"	Red		"	-	
		R.P.M. Decrease	"	"		"	Brown	
Emergency Control System	Emer brake	-	Red		White		-	
	Emer up lock release	-	Orange		Green		-	

Note: Hydraulic, power plant and emergency control systems have been described above for references.

7.1.6 Air Seal of Control Surfaces

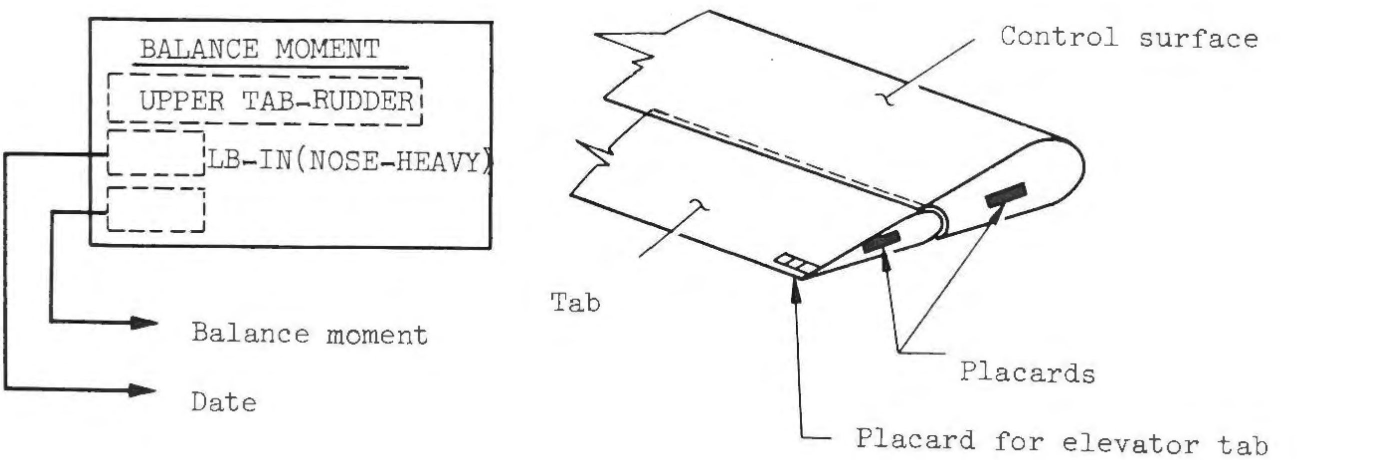
Air seal is provided on all flight control surfaces except the flaps. The air seal is installed on the leading edge of the control surface over its entire span, sealing the gap at the attaching portion of the control surface to prevent air flows on two surfaces of the control surface (upper and lower or left and right) from mixing.

As the sealing material, cloth (curtain seal) is used on the aileron and the elevator, and rubber is used on the leading edge of the rudder. Air seal is also installed on the spring tab, balance tab and trim tab. This seal consists of polyurethane attached to the rear spar of each control surface and aluminum sheet attached to the front spar of the tab, the latter compressing the former.

The flap is sealed at its up position. On the lower surface of the wing trailing edge is provided a striker made of rubber which comes in close contact with the lower surface of the flap when it is in the up position, keeping air-tightness.

7.1.7 Surface Balance Moment

On the three control surfaces and tabs (except the aileron trim tab) are attached the placards on which the balance moments are shown. These moments were measured when the airplane was completed and the placards are attached on the root rib webs, except that those for the elevator balance tab and trim tab are located on the lower skin of the root trailing edge.



Reserved

7.2 Aileron Control System

7.2.1 Attachment of Aileron

The aileron is attached to the wing trailing edge with five hinges. These hinges are numbered as follows:

No. 0 hinge	at W.Sta	9038
No. 1 hinge	at W.Sta	10162
No. 2 hinge	at W.Sta	11751
No. 3 hinge	at W.Sta	13200
No. 4 hinge	at W.Sta	14400

7.2.2 Control System (See Fig. 7-3)

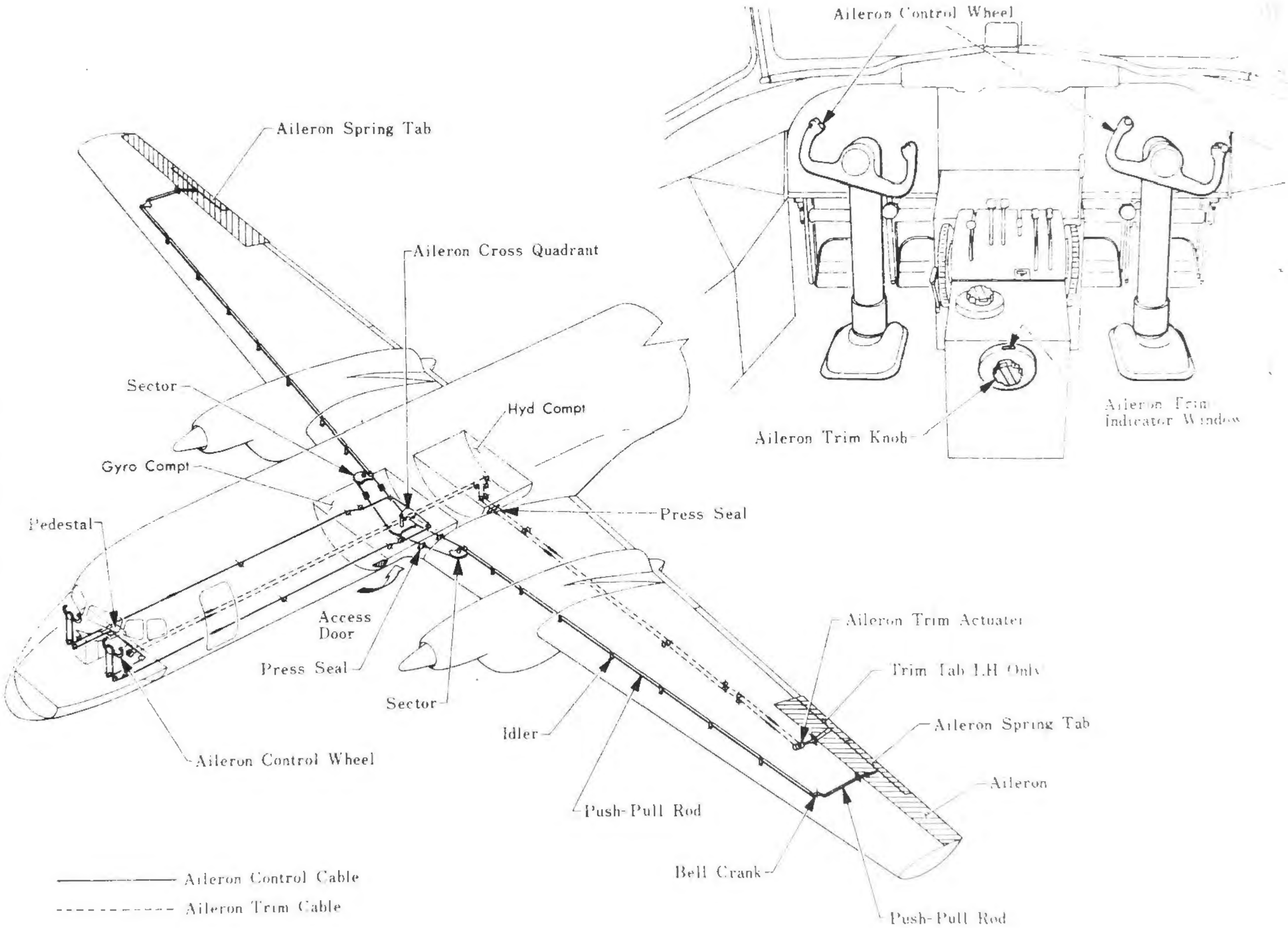
Fig. 7-3 shows the arrangement of the mechanism of the aileron control system. The aileron is controlled by rotating the aileron control wheel in the cockpit. The rotation of the wheel is transmitted to the aileron through cable and push-pull rods. The cable runs through the fuselage longitudinally and the push-pull rods run through the exhaust passage of the de-icer unit located in front of the wing front spar up to WS 11751.

In the control column heads for the pilot and the co-pilot are installed the cable drums around which two cables are wound. These cables run through the control columns to the under floor section of the cockpit. One cable is connected under the cockpit floor to the aileron control wheels for the pilot and the co-pilot. The other cable, passing through the weight saving holes of the floor beams, is connected to the upper quadrant of the aileron cross quadrant in the flight control compartment in the center of the fuselage. The aileron cross quadrant is made up of a torque tube and two quadrants (upper and lower quadrants) attached to it.

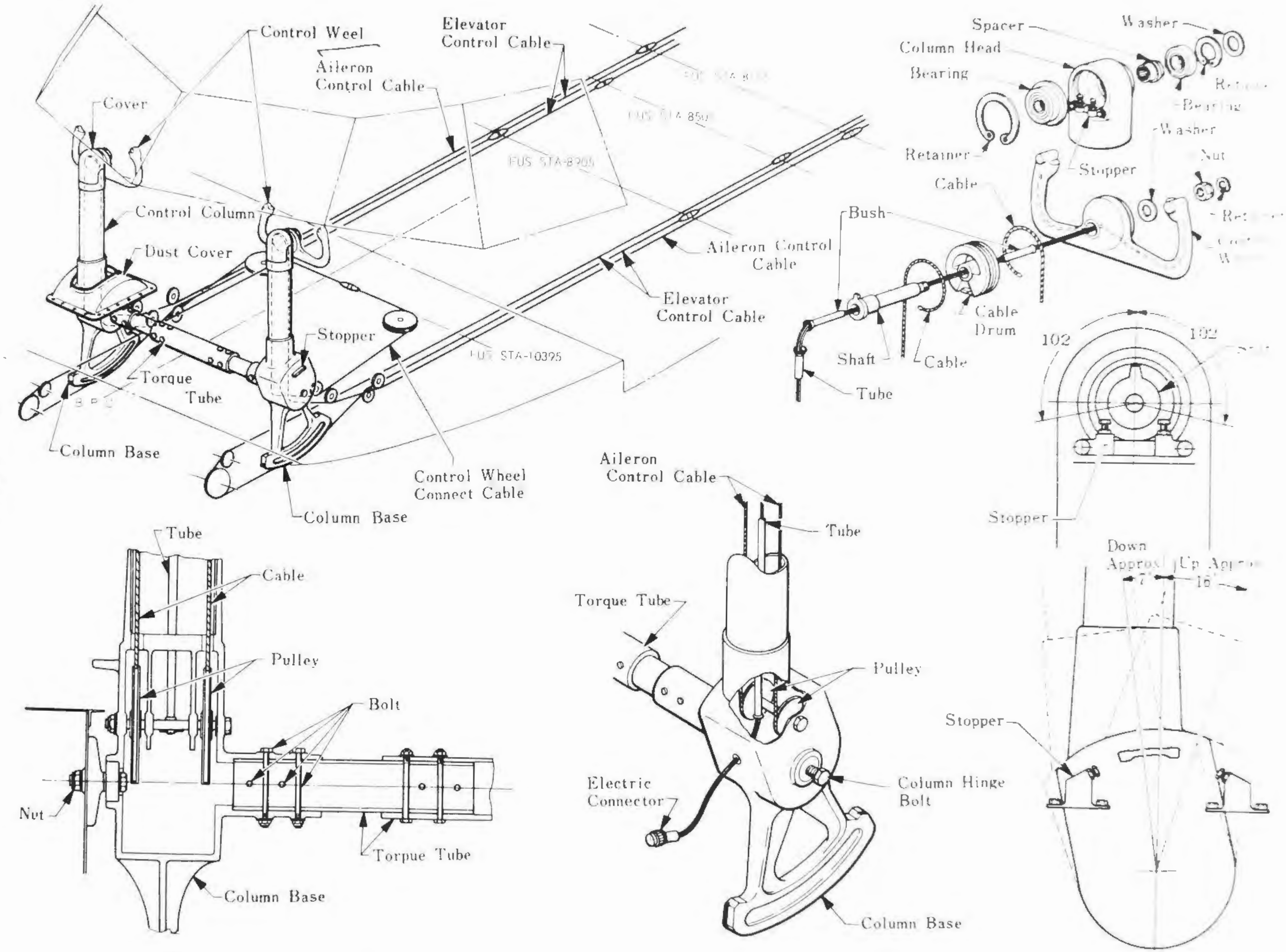
In the leading edge of the wing at its attaching section is provided a sector. To this sector is connected a push-pull rod running along the wing leading edge and it is also connected to the lower quadrant of the aileron cross quadrant in the flight control compartment with a cable.

The push-pull rod running along the wing leading edge is connected to the aileron control rod at WS 11751 through a bellcrank. The aileron control rod also serves as spring tab control rod, being connected to the aileron spring tab mechanism.

The aileron and the aileron spring tab are connected with a spring and the rotation of the aileron control wheel is transmitted to the aileron through a spring in the spring tab mechanism.



Aileron and Tab System
Figure 7-3



Control Column
Figure 7-4

Control Column Head (See Fig. 7-4)

The aileron control wheel is connected to the cable drum with a shaft with spline and the rotation of the wheel is transmitted to the drum. On the shaft is provided a protection stopper (preventing overtravelling of the control wheel) and on the column head is provided a stopper bolt.

Aileron Cross Quadrant (See Fig. 7-5)

The aileron cross quadrant is installed at F.Sta-2050, being made up of a torque tube and upper and lower quadrants attached to it. This torque tube is supported by floor beams and keel ball bearings in the lower part of the fuselage. On the lower part of this torque tube are provided the aileron bungee spring and the aileron gust lock quadrant. The aileron bungee spring is fixed to the torque tube of the quadrant and a fuselage frame, correlating the angular motion of the aileron and the control force linearly.

Push-pull Rod (See Fig. 7-5)

Eight push-pull rods of 45 mmø are connected in series in the wing leading edge with idle arms, being connected to the bellcrank at WS 11800. On the following three rods,

BP 1200 ~ WS 860

WS 8430 ~ WS 10030 and

WS 10030 ~ WS 11800

are provided rod ends so that their length can be adjusted but other rods can not be adjusted. The rod ends for length adjustment are located on idle arms and bellcrank attachments at WS 10030 and WS 11800.

7.2.3 Spring Tab Mechanism (See Figs. 7-5 and -6)

The aileron control rod is connected to the aileron through a spring. Therefore, in order to control the aileron, the tab is controlled first and then the air force moves the aileron.

7.2.4 Stopper for the System and its Functions (See Fig. 7-5)

The aileron control system has the following four stoppers:

(1) Aileron travel angle stopper

(2) Spring tab stopper

(3) Bellcrank stopper

(4) Control wheel stopper

(1) is a stopper for the aileron travel angle; a stop bolt being provided on the wing trailing edge (WS 9517) and a stopper made of aluminum alloy on the aileron leading edge which restricts the aileron travel angle.

(2) is a stopper for the spring tab, installed in the spring tab mechanism, restricting the spring tab travel angle.

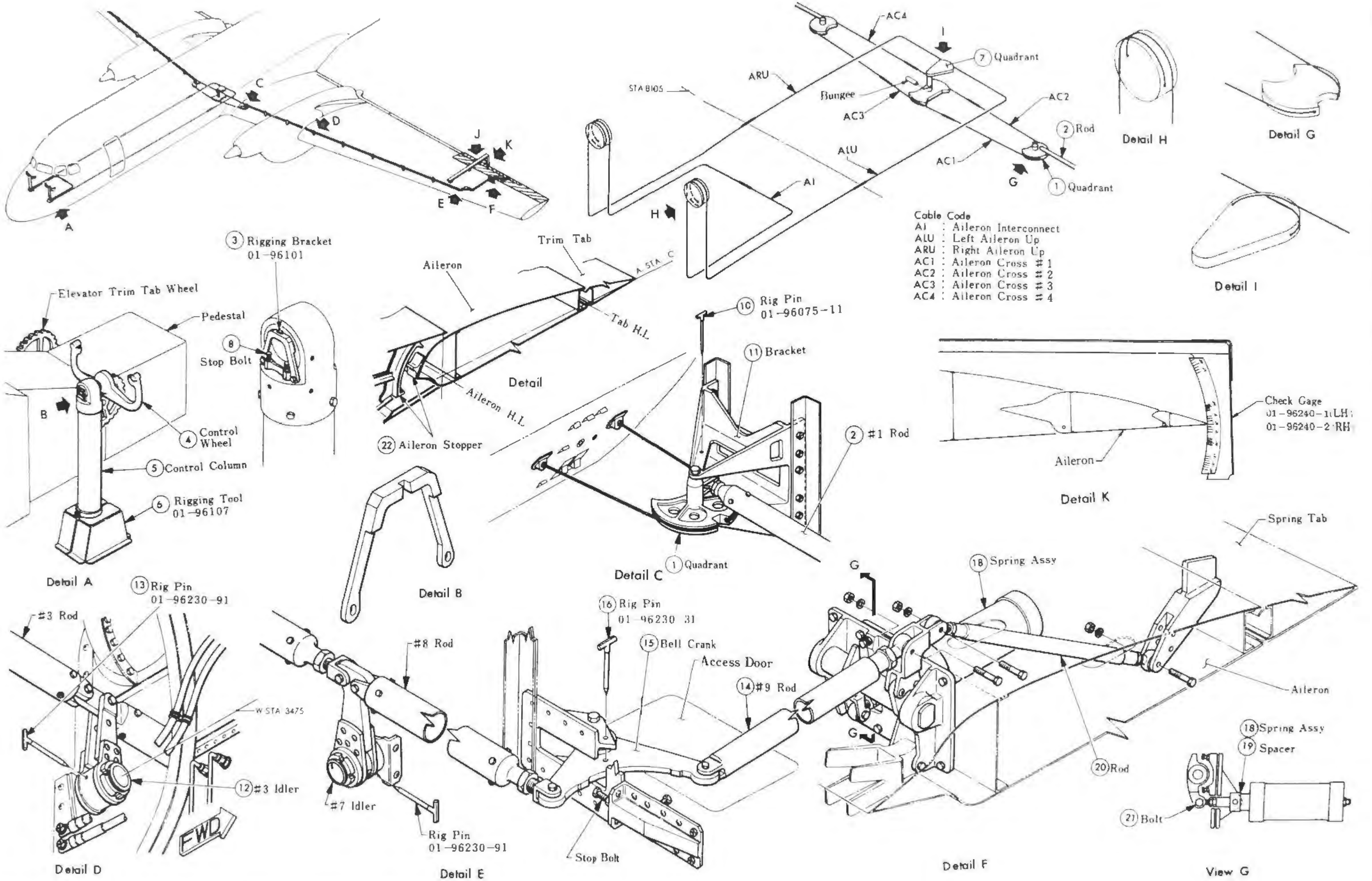
(3) is a stopper for the bellcrank, located at WS 11800, consisting of two bits, one on the forward side of the wing front spar and another on the rear side. This stopper restricts the over-travelling of the push-pull rod provided on the forward side of the wing front spar. Viewing from the control surface side, this restricts the sum of the aileron angle and the spring tab angle.

(4) is a stopper for the aileron control wheel, located on the control column head. This protects the system. After the bellcrank comes in contact with its stopper, this stopper restricts further travel, avoiding excessive force to the system.

7.2.5 Procedures for the System Adjustment (See Figs. 7-4 and 7-5)

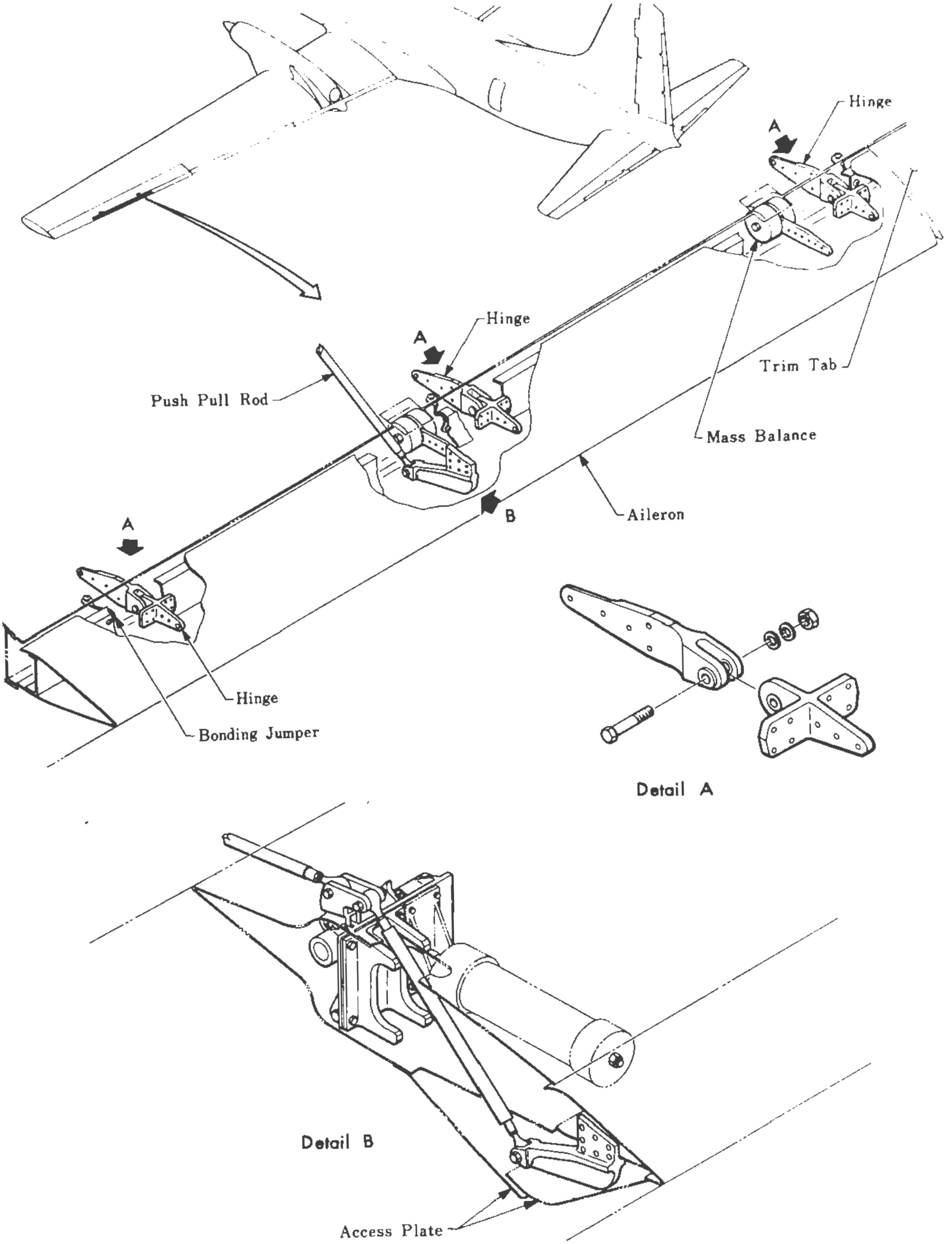
(1) Neutral Points of the System (8 locations)

Number	Fixed to	Location	Fixing Method
1	Aileron control wheel	Column head	Rigging tool
2	Control column	Column base	Rigging tool
3	Aileron cross quadrant	Flight control compartment	Gust lock "ON"
4	Sector	BP 1200	Rigging pin
5	Aileron control rod	WS 3475	Rigging pin
6	Idle arm	WS 10030	Rigging pin
7	Bellcrank	WS 11800	Rigging pin
8	Spring tab	Spring	Fixing spacer



Aileron Control System Rigging

Figure 7-5



Aileron Spring Tab Hinge
Figure 7–6

(2) Procedures for adjustment

Adjustment of fuselage side

A. Fix numbers 1 to 4 and tighten the cable in the fuselage. The cable tension is 150 lb $\pm$ 10 lb ($\pm$ 1.4 lb /°F) at 70°F.

B. The position of the stop bolt of the aileron control wheel is determined lastly.

Adjustment of wing leading edge control rod

C. Fix numbers 4 to 7 and adjust the length of the control rod.

Adjustment of aileron control rod

D. Fix numbers 7 and 8 and adjust the length of the control rod, setting the aileron to 0° with a contour gauge.

Adjustment of each stopper

E. Adjust the stoppers for the aileron and the spring tab using the contour gauge used in the preceding paragraph D individually so that their respective travel angles can be obtained.

F. Adjust the bellcrank stopper so that the bellcrank begins to move when the aileron control wheel is turned by 90° $\pm$ 0.5°.

G. Adjust the stop bolt so that the aileron control wheel stopper can come into action when a load of 27 $\pm$ 1 kg is applied to a point at 165.0 R from the rotating center of the aileron control wheel after the stopper mentioned in F began to work.

NOTE: Keep removed the bungee spring in the flight control compartment.

7.3 Aileron Trim Tab Control System

7.3.1 Attachment of Trim Tab

The trim tab is attached to the aileron trailing edge with a piano hinge.

7.3.2 Trim Tab Control System (See Figs. 7-7 and 7-8)

The aileron trim tab can be controlled by rotating the control knob on the center pedestal in the cockpit. The pedestal is provided with an indicator box which shows the amount of the aileron trimming (trim tab angle).

The rotation of the control knob is transmitted to the cable drum located under the cockpit floor through chains, bevel gears and torque tubes. A cable from the cable drum, passing through the weight saving holes of the floor beams, reaches the hydraulic compartment, from which it runs through the fuselage to the rear side of the L.H. wing rear spar, transmitting the rotation of the control knob to the screw jack type trim actuator

located at WS 10015. The trim actuator controls the trim tab, by pushing or pulling the trim control rod.

7.3.3 Indicator Box (See Fig. 7-9)

The trim control knob rotates from the 0 position to the left and to the right by 4.1 turns. Consequently, the reading of the indicator is reduced by the idler gear so that all the indication can be shown on the dial face.

The indicator scale has the following marking on it with 21 graduations:

Knob rotation	Indication	Tab position
Clockwise	Black	Up
Counter clockwise	Red	Down
0 position	Green	0

7.3.4 Procedures for Trim System Adjustment

(1) Neutral Fixed Points of the System (3 locations)

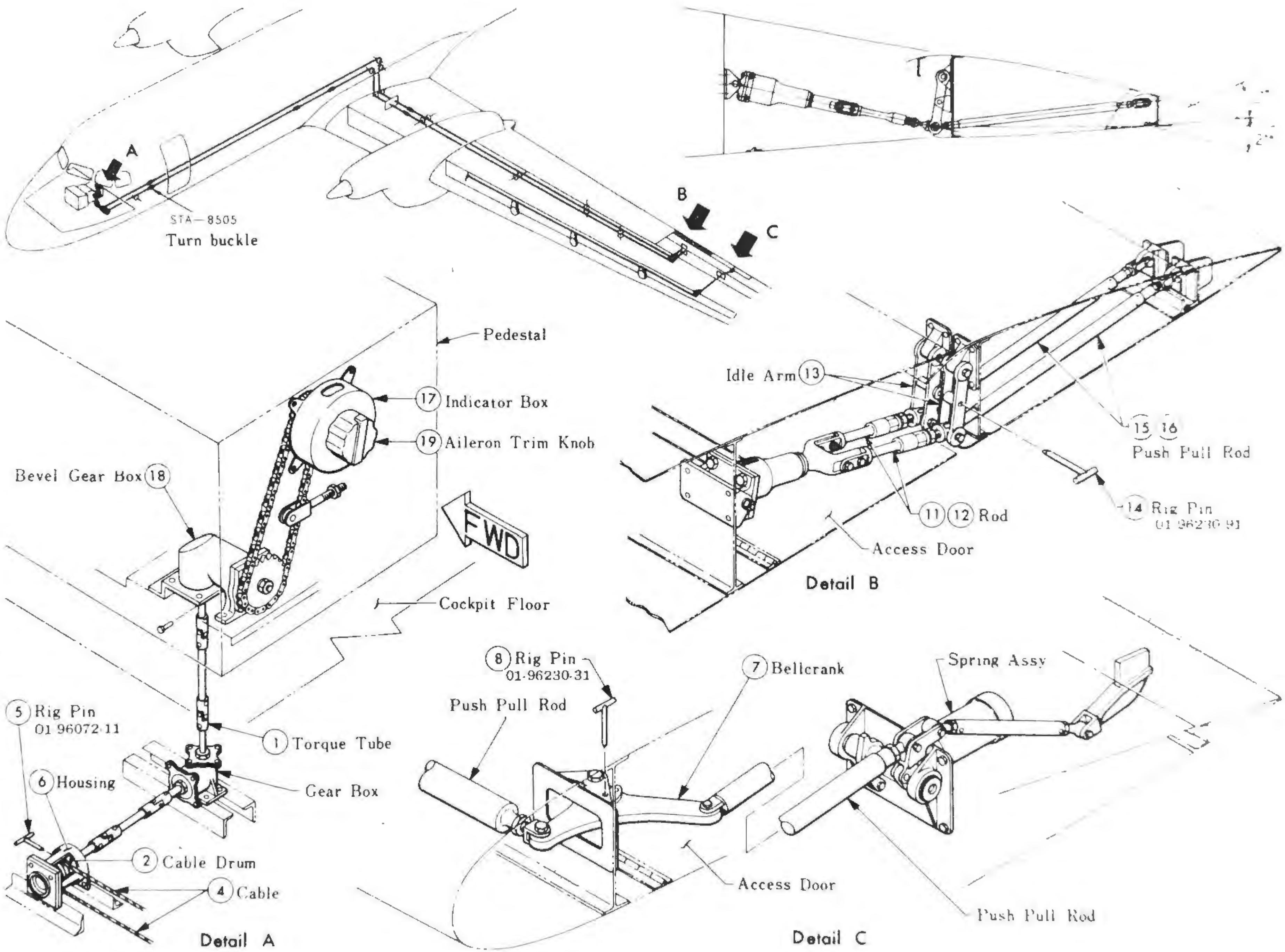
Number	Fixed to	Location	Fixing method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Acme screw shaft	Align the red mark.
3	Control rod	Idle arm	Rigging pin

(2) Procedures for adjustment

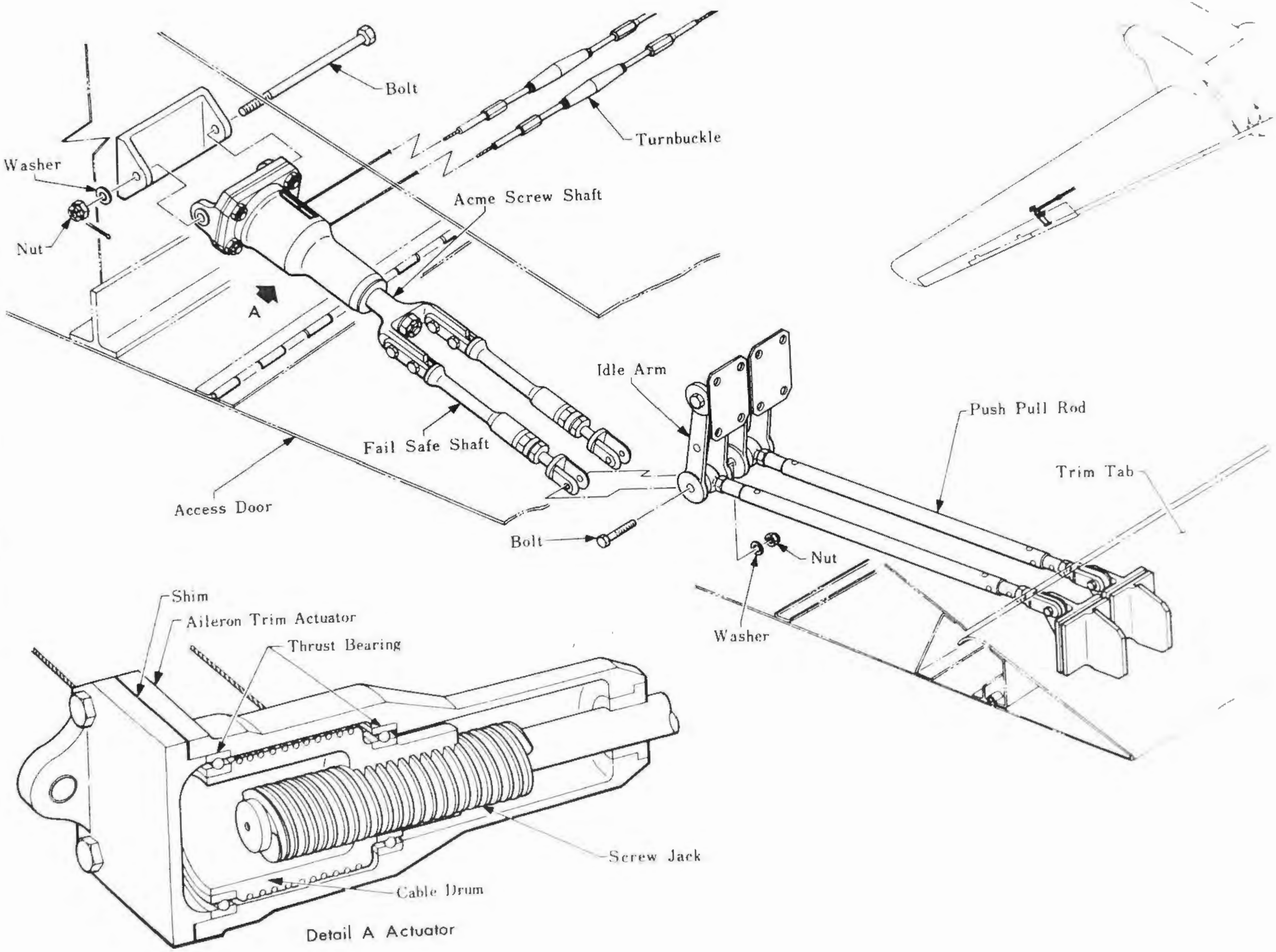
A. Fixing numbers 1 and 2, tighten the cable. The cable tension at 70°F is 30 ± 5 lb (±0.4 lb/°F).

B. Fixing numbers 2 and 3, adjust the length of the control rod, setting the trim tab to 0° with a contour gauge.

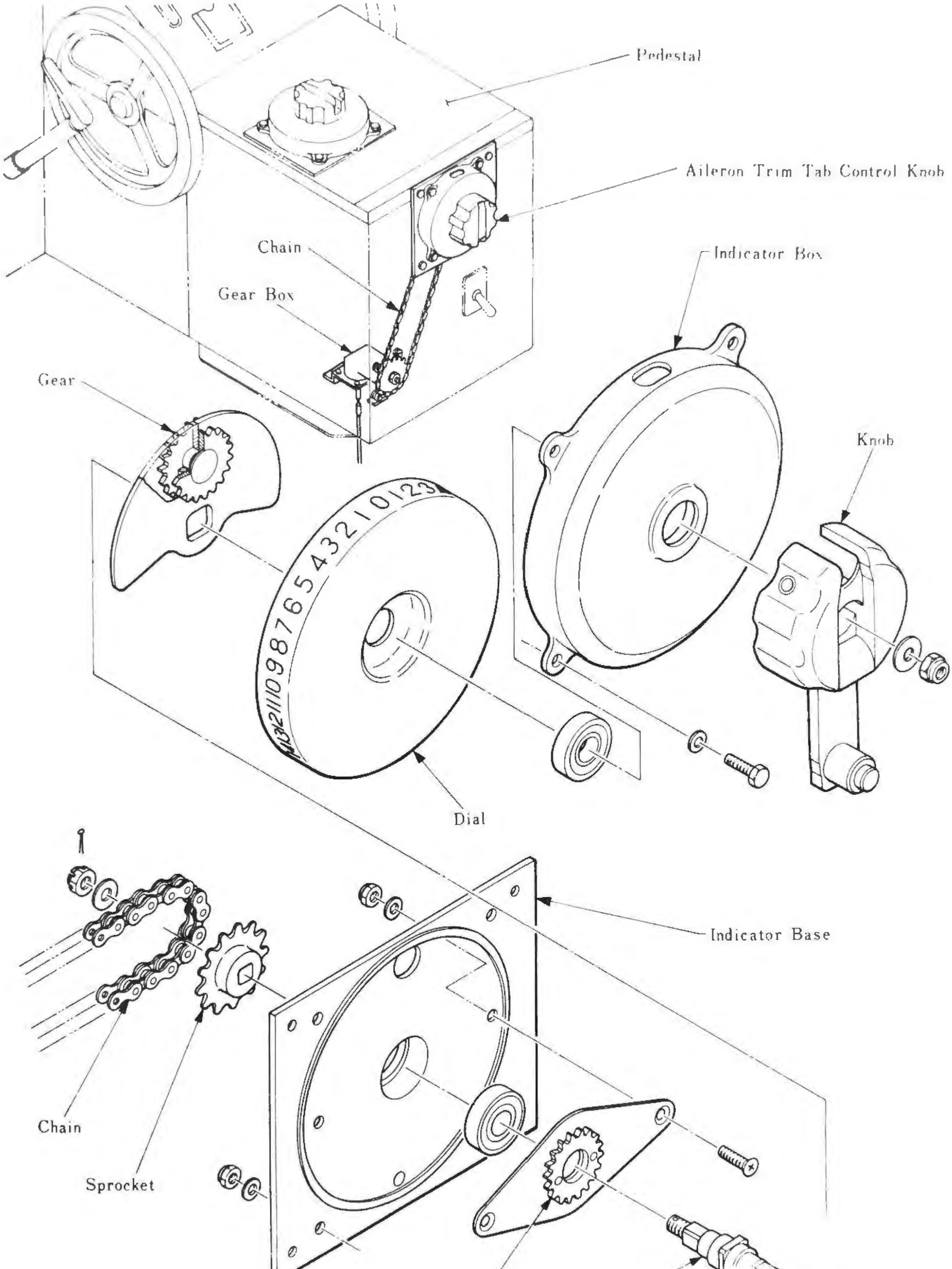
C. The stopper for the trim system is contained in the indicator box. After 3 turns of the control knob, the stopper comes into action and no further movement can not be obtained.



Aileron Trim Tab Control System Rigging
Figure 7-7



Aileron Trim Tab Actuator
Figure 7-8



Aileron Trim Indicator
Figure 7–9

7.4 Rudder Control System

7.4.1 Attachment of Rudder (See Fig. 7-15)

The rudder is attached to the vertical stabilizer with three hinges. The weight of the rudder is supported by the lowest hinge.

7.4.2 Rudder Control System (See Fig. 7-10)

The rudder can be controlled by pushing the L.H. and R.H. pedals provided for the pilot and the co-pilot.
To each pedal is attached a rod which is connected to the forward quadrant (above the floor) in the cockpit. Quadrants are provided 1 ea. in front of the pilot seat and the co-pilot seat, both being connected with a beam and equalizing the movement of the rudder pedals for the pilot and the co-pilot.

On the rudder pedals for the pilot and the co-pilot are provided pedal adjust knobs with which the pedal positions can be adjusted, individually.

To each forward quadrant in the cockpit is attached a cable. This cable, passing through the weight saving holes on the floor beams below the floor, runs upwards by means of a pulley behind the pressure bulkhead at F.Sta +9035 and above the horizontal stabilizer, and it is connected to the quadrant with the tension regulator attached to the rudder torque tube (rudder lower assembly).

Pedal Adjust Mechanism (See Fig. 7-14)

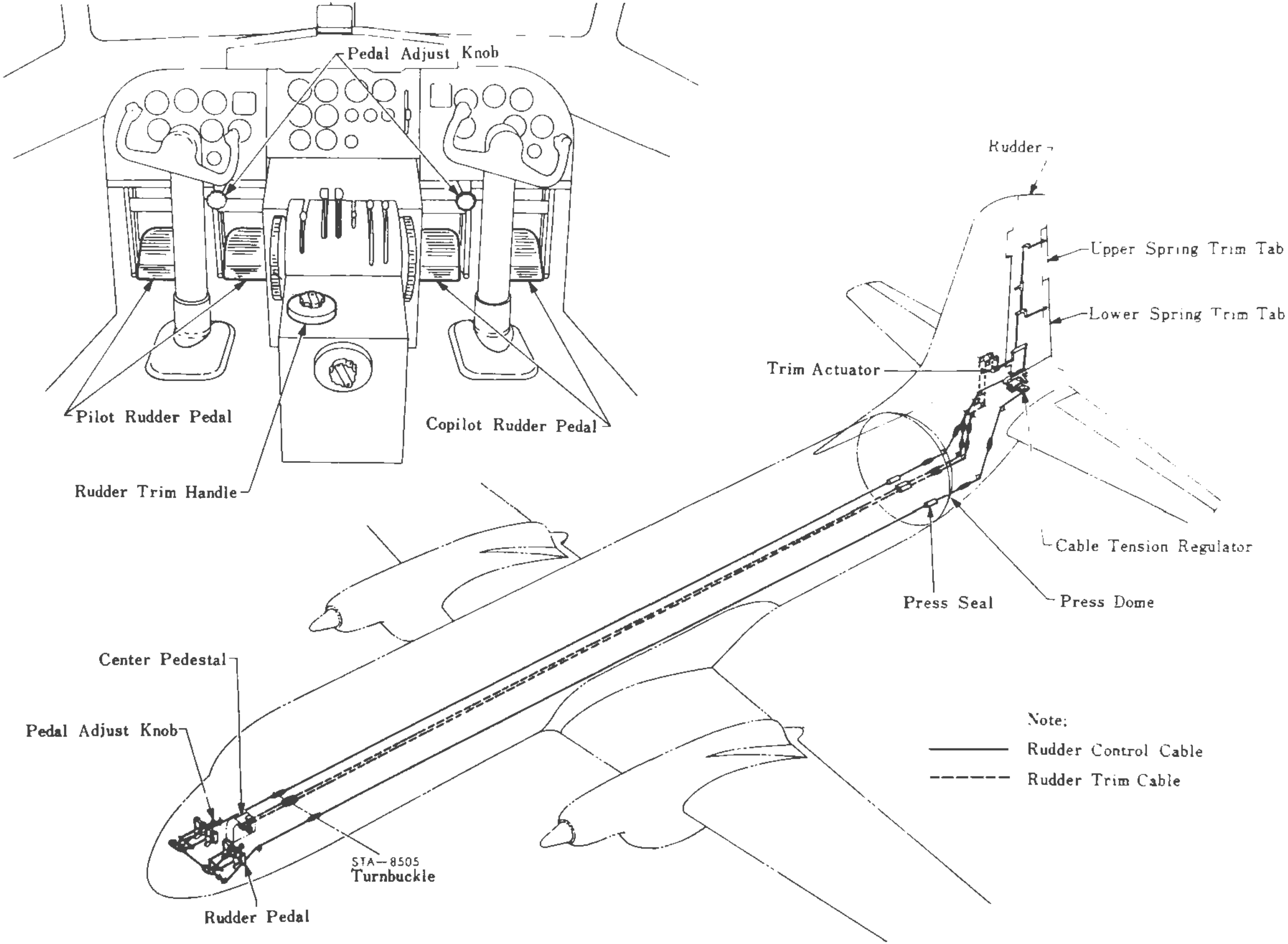
If the pedal is pushed, the force is transmitted to the arm, rotating the quadrant around its rotating axis through links and adjusters.
If the pedal adjust knob is rotated, its angle of rotation is transmitted to the screw. Since the screw does not move with respect to the quadrant, the adjuster moves fore and aft. This movement is converted into the rotation of the arm and, consequently, the rudder pedal can be moved fore and aft for adjustment without moving the quadrant.
The rudder pedal can be adjusted within 60.5 mm in the forward direction and 59.5 mm in the rearward direction.

7.4.3 Rudder Spring Tab Mechanism

The operating principle of the mechanism is the same as that for the aileron. The rudder spring tab mechanism consists of the lower assembly and the upper assembly.

(1) Lower Assembly (See Fig. 7-14)

On the lower part of the rudder is provided a torque tube 80 mm in the rear of the rudder hinge line. The control force is transmitted to this torque tube to rotate it. On this torque tube is installed the spring tab mechanism. On a plane perpendicular to the rudder hinge line are provided in parallel each other 2 sets of triangular plates, each set consisting two plates and these sets of the plates can rotate around the rudder hinge line freely.



Rudder and Tab System
Figure 7-10

One set of the plates (A set) is fixed on the rudder torque tube (on the uppermost part and the lowest part), rotating around the hinge line together with the rudder. Therefore, it is considered to be a part of the rudder torque tube. On the other set of the plates (B set) is built the quadrant with a tension regulator. This set can rotate around the rudder hinge line freely, moving in relation to the plates of the A set.
The B set is attached to the plates of the A set with long bolts around which the plates of the B set can rotate freely.
With respect to the upper and lower plates in two sets one end of each plate other than the hinge line is installed with a long bolt and the spring of the spring tab mechanism is installed between those bolts.
To the plates of the B set are connected to the tab actuating link mechanism, transmitting the deflection of the spring to the upper assembly to actuate it.

(2) Upper Assembly (See Figs. 7-12 and 7-14)

In the rudder is provided the link mechanism for the spring tab control rod. This link mechanism is connected to the rudder trim control mechanism at V.Sta 430. The tab consists of the upper tab and the lower one, both ~~moving~~ in the same fashion.

(3) Operation (See Fig. 7-11)

The bottom end of the rod X is connected to the tension regulator of the lower assembly, the upper end of the rod Y to the bellcrank at V.Sta 1355 and the left end of the rod Z to the trim actuator.

a. When spring tab only is operated without operating trim.

Rotate the arm of the spring tab around the hinge point β and transmit the deflection of the spring to the rod Y.

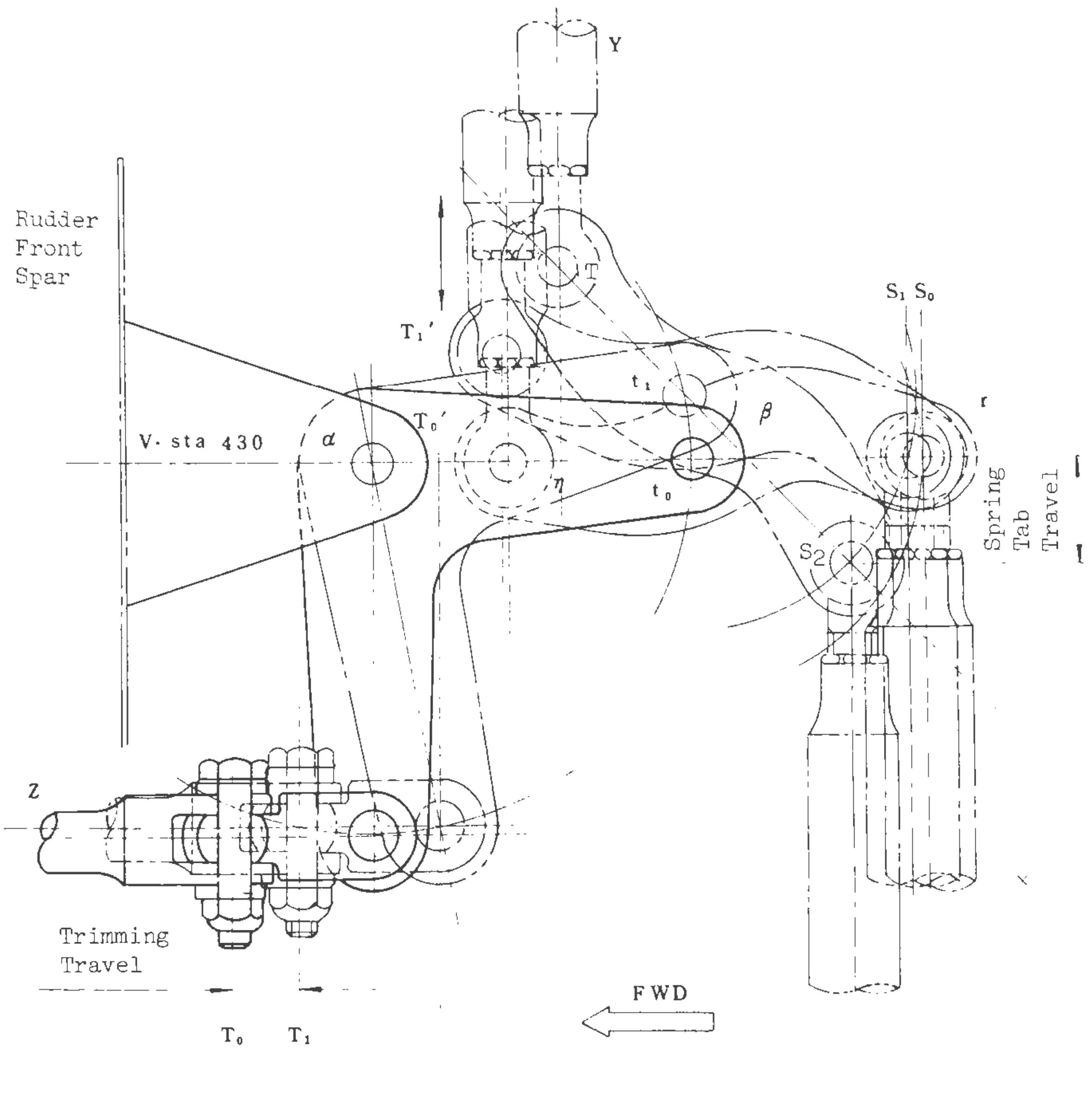
b. When trim only is operated without operating spring tab.

The trim control rod moves from T_0 to T_1 and the bellcrank rotates around a point α. As a result, the point β of the arm moves from t_0 to t_1. As the rod X can not actuate the spring of the spring tab since the bottom end of the rod X is connected to the tension regulator, the point γ moves from S_0 to S_1 horizontally. The point η moves from T_0' to T_1', actuating the tab.

c. When spring tab is operated under the above conditions a and b.

The point γ moves from S_1 to S_2.
The point β remains standstill at t_1.
The point η moves from T_1' to T.

The total movement of the tab amounts to the sum of ($T_0' \rightarrow T_1'$) and ($T_1' \rightarrow T$).



Link Mechanism at V.Sta 430

Figure 7–11

7.4.4 Rudder Cable Tension Regulator (See Figs. 7-12 and -13)

The cable tension regulator is installed on the lower part of the torque tube of the rudder assembly together with the rudder spring tab control mechanism.

The regulator consists of the sector which can rotate around the rudder hinge line freely, spring with which the control cable tension is adjusted, rod which connects the sector and the spring with the regulator shaft and support. With respect to the hinge line, the cable is balanced at a specified position by moment of the spring force and cable tension.

If the cable and the airframe expand or contract as the temperature changes, the tension of the two cables change by an equal amount. As a result, two sectors rotate at a new position corresponding to the spring force, maintaining the cable tension at a constant value.

The moment change to the hinge line of the two sectors has the same absolute value with opposite directions, being balanced as a whole and it does not rotate the rudder. While the aircraft is being controlled, the moment of the sector is uneven and unbalanced and the sectors rotate around the rudder hinge line, permitting the rudder control.
The tension regulator is provided the compensation scale, showing the tensile strength of the rudder cable.

7.4.5 Stopper and Functions of Rudder Control System. (Fig. 7-14)

The stoppers of the rudder control consists of three

(1) Rudder Stopper

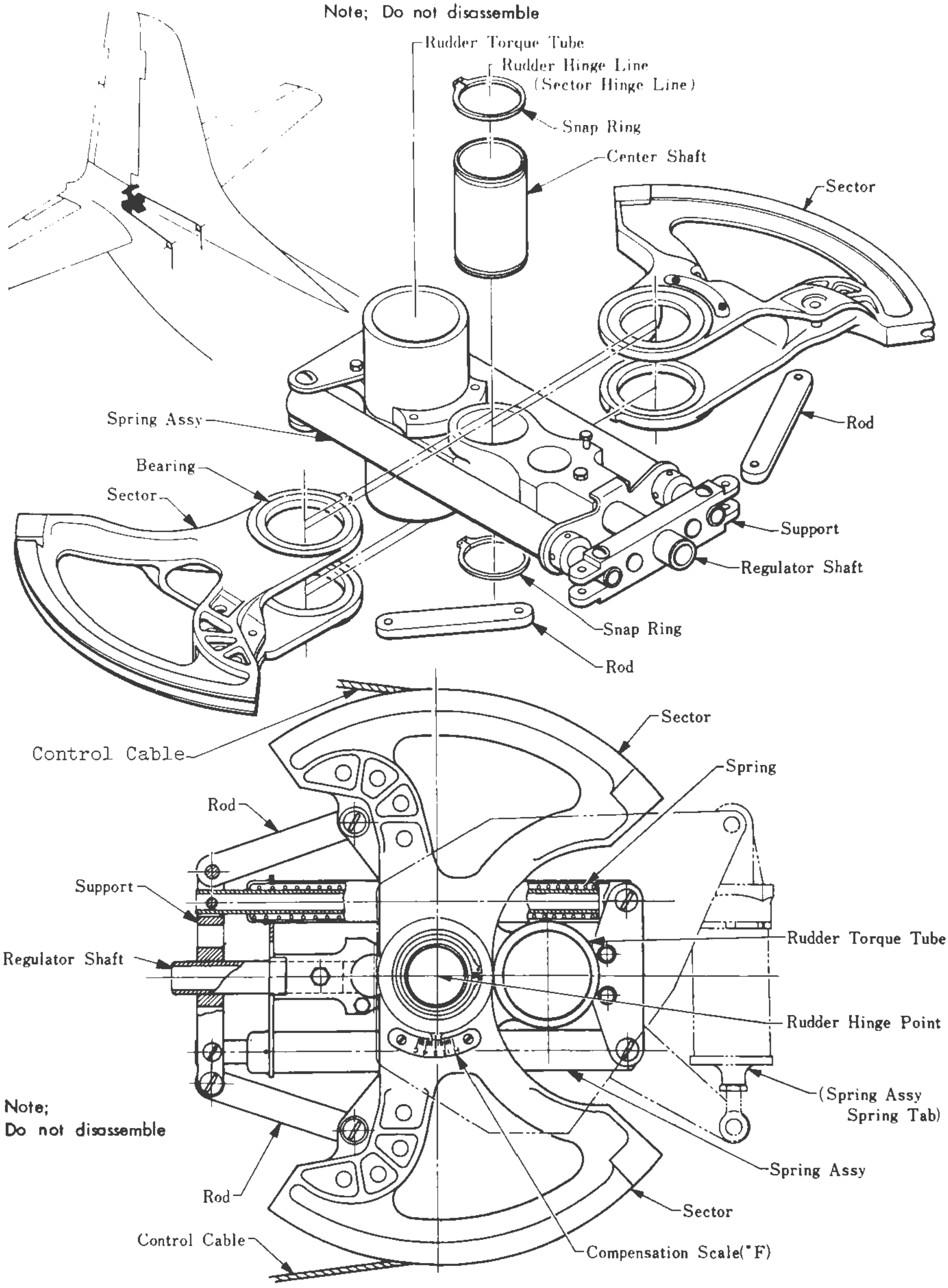
(2) Spring Tab Stopper

(3) Quadrant Stopper in the forward part in the cockpit.

(1) has a stopper arm on the torque tube of the rudder lower part and the stop bolt is located in the rear of the vertical stabilizer. It restricts the rudder angle.

(2) has a spring tab stopper on the lower assembly of the tab mechanism. It restricts the angle of control surface.

(3) has a stopper of the forward quadrant in the forward quadrant.
This protects the system so that excessive load can not be applied to the system.



Rudder Control Cable Tension Regulator

Figure 7-12

7.4.6 Procedures for System Adjustment (See Fig. 7-14)

(1) Neutral fixed points of the System (6 locations)

Number	Fixed to	Location	Fixing Method
1	Rudder pedal	Pedal arm	Rigging pin
2	Forward quadrant	Quadrant	Rigging pin
3	Quadrant with tension regulator	Rudder	Gust lock "ON"
4	Bellcrank	V.S. 430	Rigging pin
5	"	V.S. 1280	"
6	"	V.S. 3030	"

(2) Adjusting Procedures

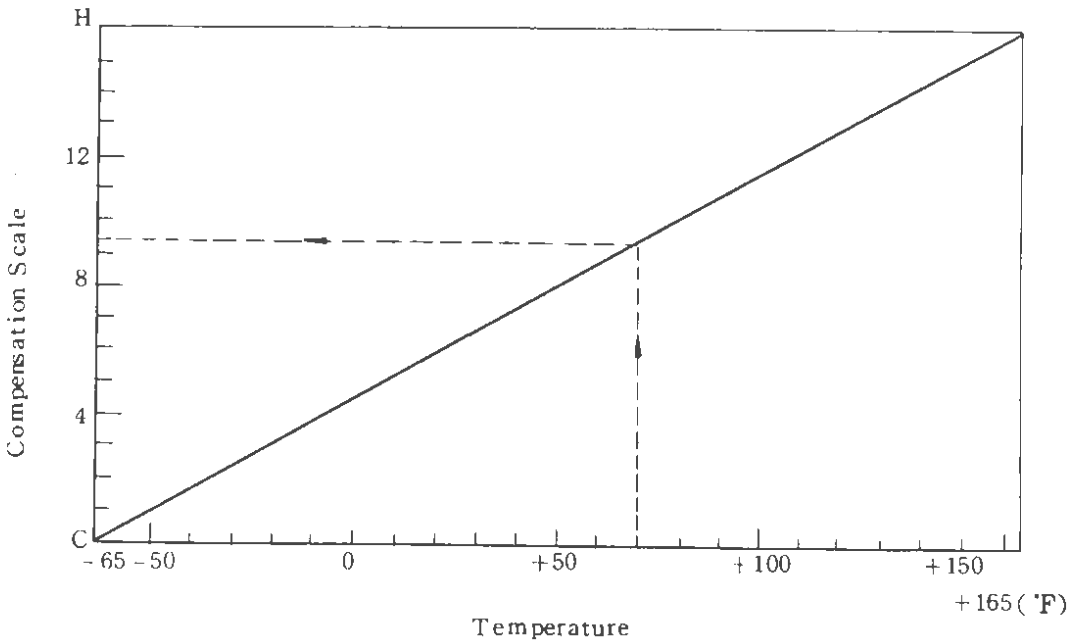
On Fuselage Side

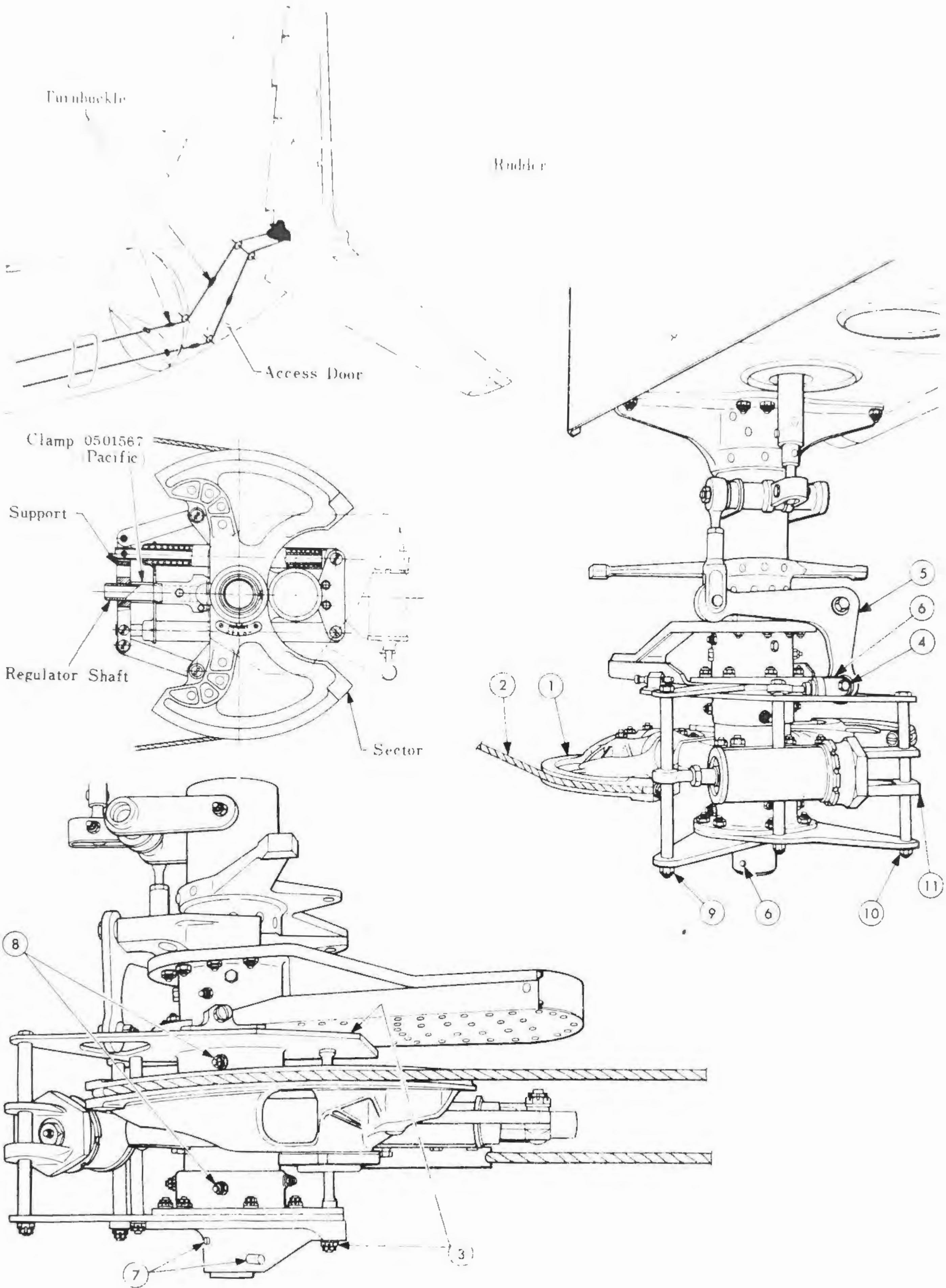
A. Fix number 3 and

B. Fix number 2 and tighten the cable.

C. Fixing number 1, adjust the length of the pedal arm and adjust the length of the pedal adjusting mechanism and the rod.

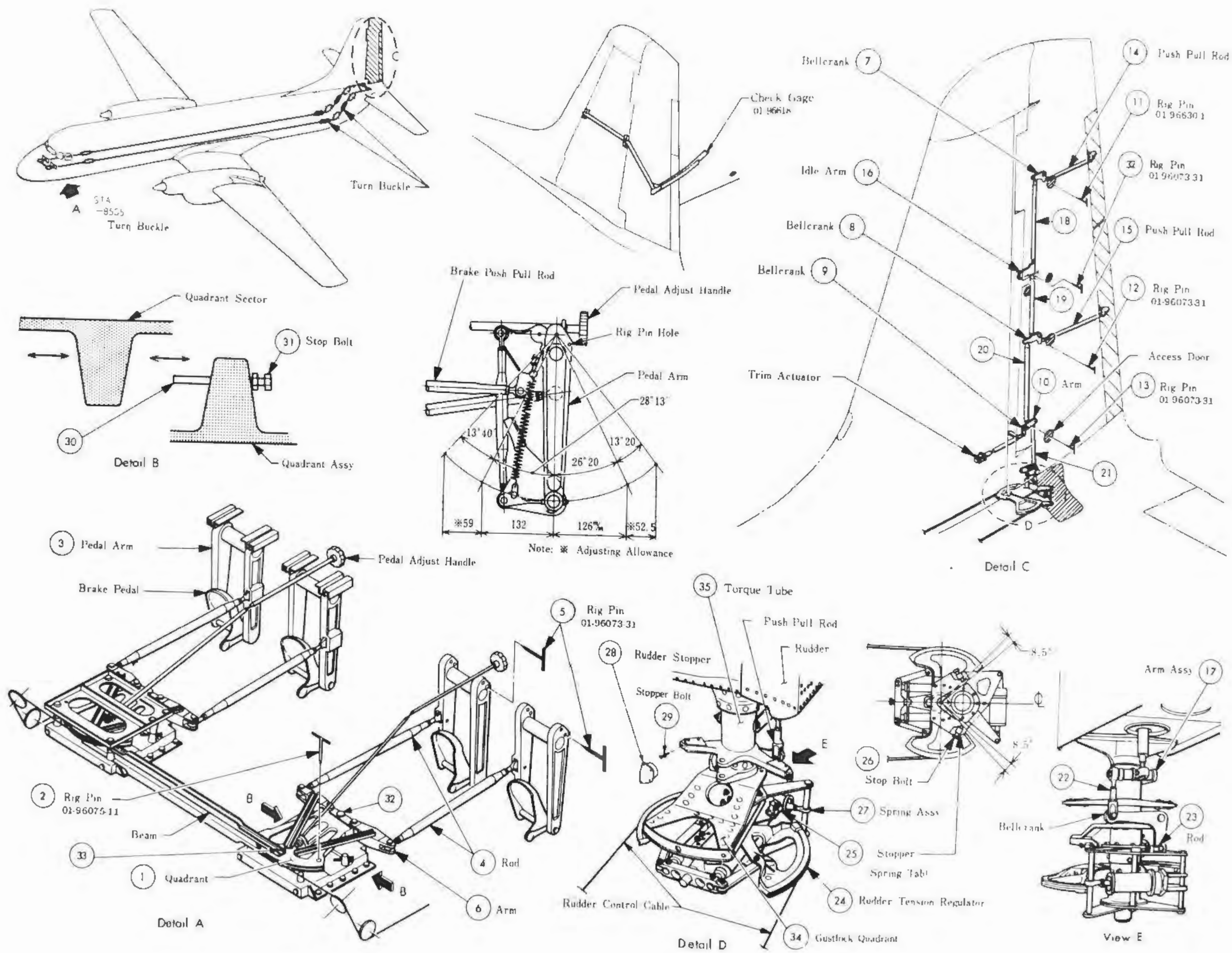
Tighten the cable in accordance with the graph of the following compensation scale:





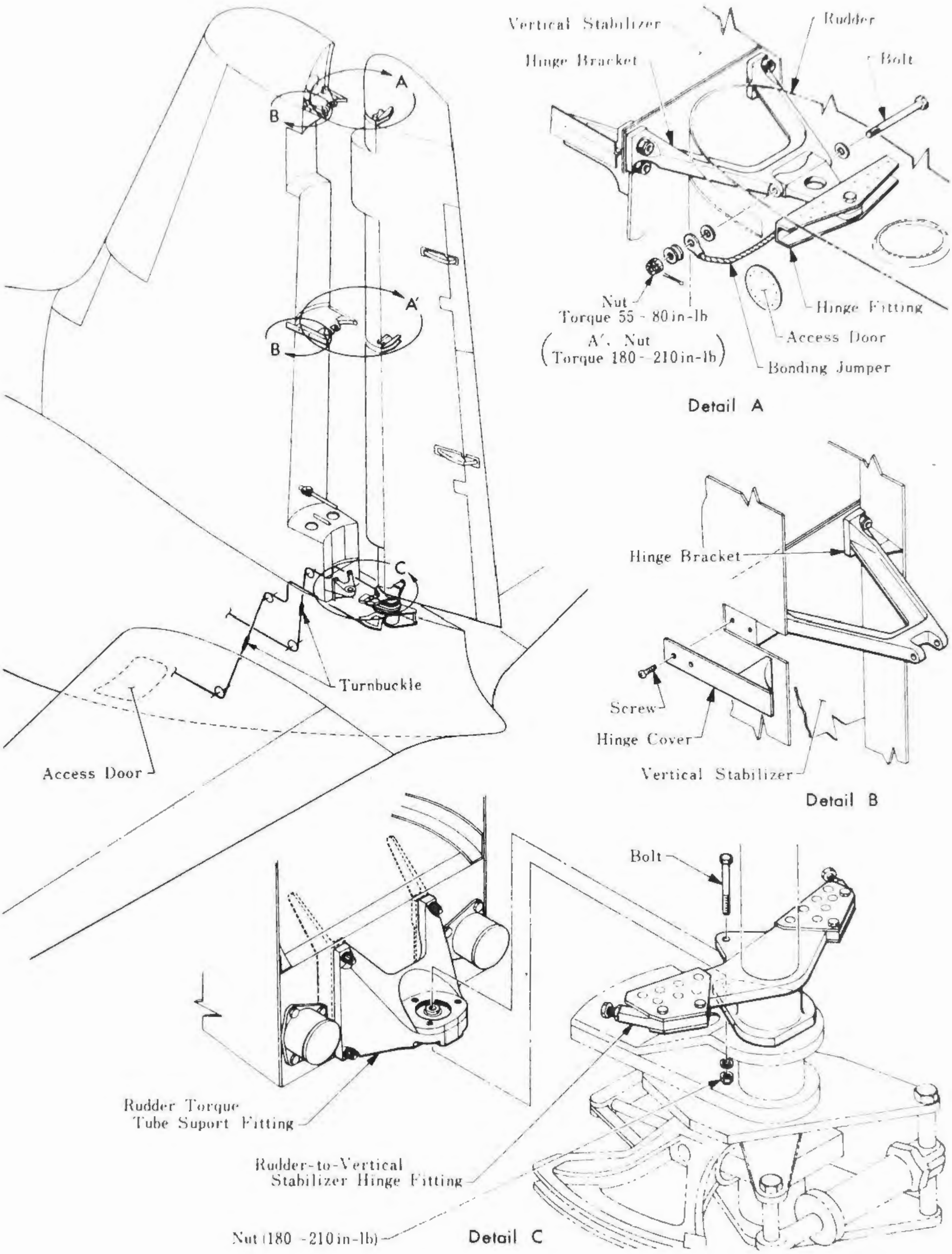
Rudder Control Cable Tension Regulator Remove Installation

Figure 7-13



Rudder Control System Rigging

Figure 7-14



Rudder Hinge

Figure 7-15

On Rudder Side

D. Fixing numbers 3 to 6, adjust the spring tab. This is accomplished by setting the rudder and the spring tab to 0° with the angle gauge and adjust the length of each rod.

Adjustment of Each Stopper

E. Depress the rudder pedal and adjust the spring tab stopper so that the rudder travel angle measured by the angle gauge is within the specified limits.

F. Adjust the rudder stop bolt so that the specified angle is attained when the rudder pedal is depressed further.

G. Adjust the stop bolt of the forward quadrant stopper in the cockpit so that the quadrant comes in contact with the stopper when 82 kg ± 2 Kg weight is placed on the rudder pedal after the stoppers mentioned in E and F come into action.

7.5 Rudder Trim Tab Control System

7.5.1 Attachment of Spring and Trim Tab (See Fig. 7-16)

The spring tab and the trim tab are controlled by a control mechanism, being divided into two tabs, upper tab and lower one. The upper tab and the lower tab are attached to the rudder tab hinge fittings with two hinge bearings and three, respectively.

7.5.2 Rudder Trim Tab Control System (See Fig. 7-17)

The rudder trim tab can be controlled by rotating the rudder trim tab control knob on the center pedestal in the cockpit. The rotation of the control knob is transmitted to the cable drum below the cockpit floor through the torque tubes and bevel gears. A cable from the cable drum passes the weight reducing holes of the floor beams, bends up at the pulley at FUS. Sta + 9484 behind the pressure bulkhead and transmits the rotation of the control knob to the screw jack type trim actuator located at V.Sta 345 in the vertical stabilizer. A push-pull rod connected to the trim actuator, in turn, controls the tab.
On the pedestal is provided the indicator box, indicating the amount of the rudder trim control (trim tab angle).

7.5.3 Indicator Box (See Fig. 7-19)

The rotation of the trim control knob which rotates to the left and to the right by 4.3 turns, respectively, is reduced by the reduction gears and its indication is shown on the dial of the indicator with graduations on the entire face.

Graduations of Indicatior

Rotation of Knob	Indication	Tab Position
Clockwise	Black	Left
Counterclockwise	Red	Right
0	Green	0

15 graduations are marked on both L.H. and R.H. sides.

7.5.4 Procedures for Trim Tab System Adjustment (See Fig. 7-17)

(1) Neutral fixed points of System (3 locations)

Number	Fixed to	Location	Fixing Method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Vertical stabilizer at V.Sta 380	Rigging pin
3	Push-pull rod	V.430, Bellcrank	Rigging pin

(2) Adjusting Procedures

A. Place the rudder in the neutral position (gust lock "ON").

B. Fix number 1.

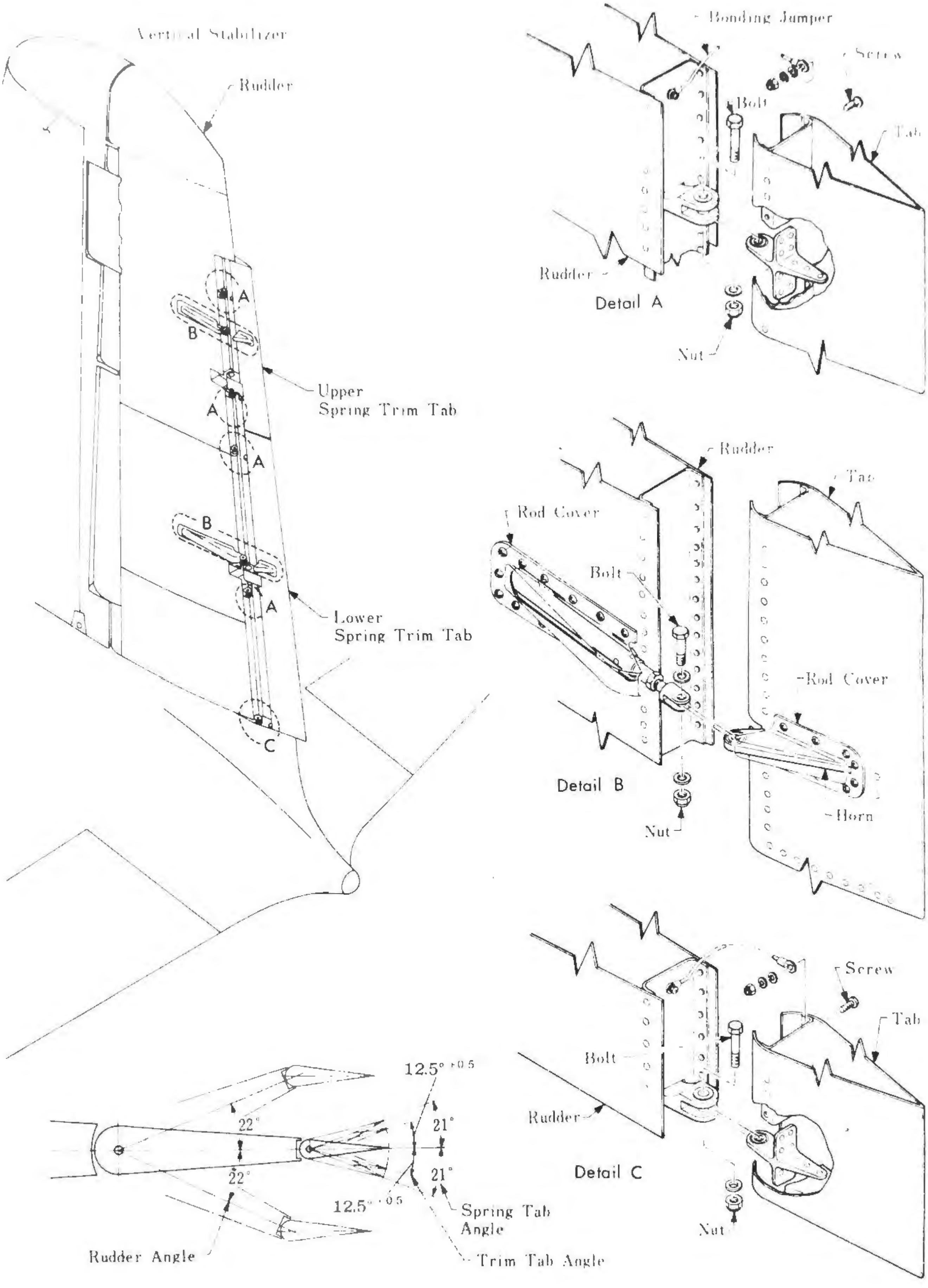
C. Fix number 2.

D. Tighten the cable. The cable tension should be 30 ± 5 lb (±0.4 lb/°F) at 70°F.

E. Fix numbers 2 and 3. Adjust the length of the push-pull rod if adjustment of the spring tab has been completed.

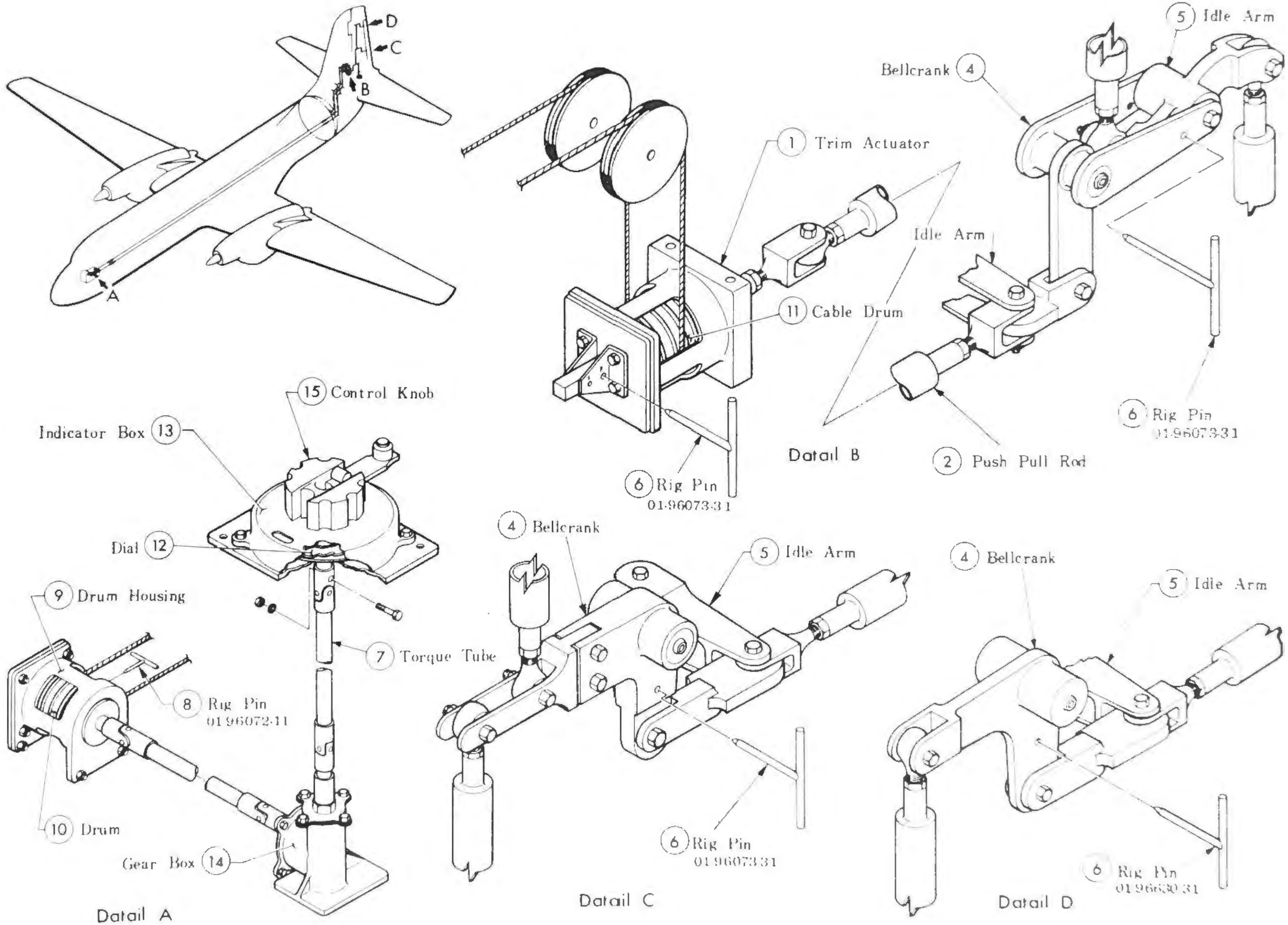
Adjustment of Stopper

F. The stopper for the trim system is built in the indicator box. If the control knob is rotated to the full, the stopper comes into action and no further movement is possible.

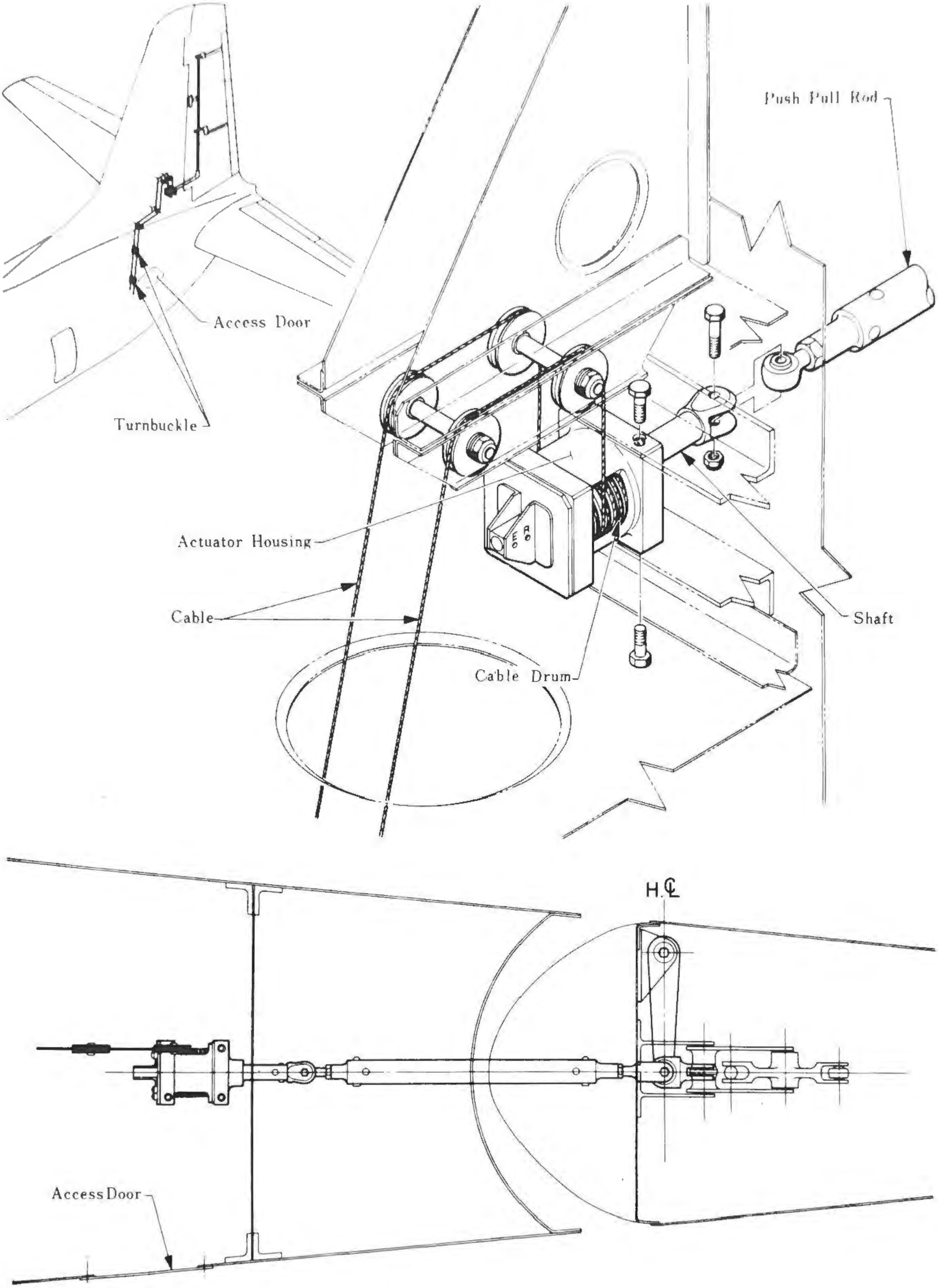


Rudder Spring Trim Tab Hinge

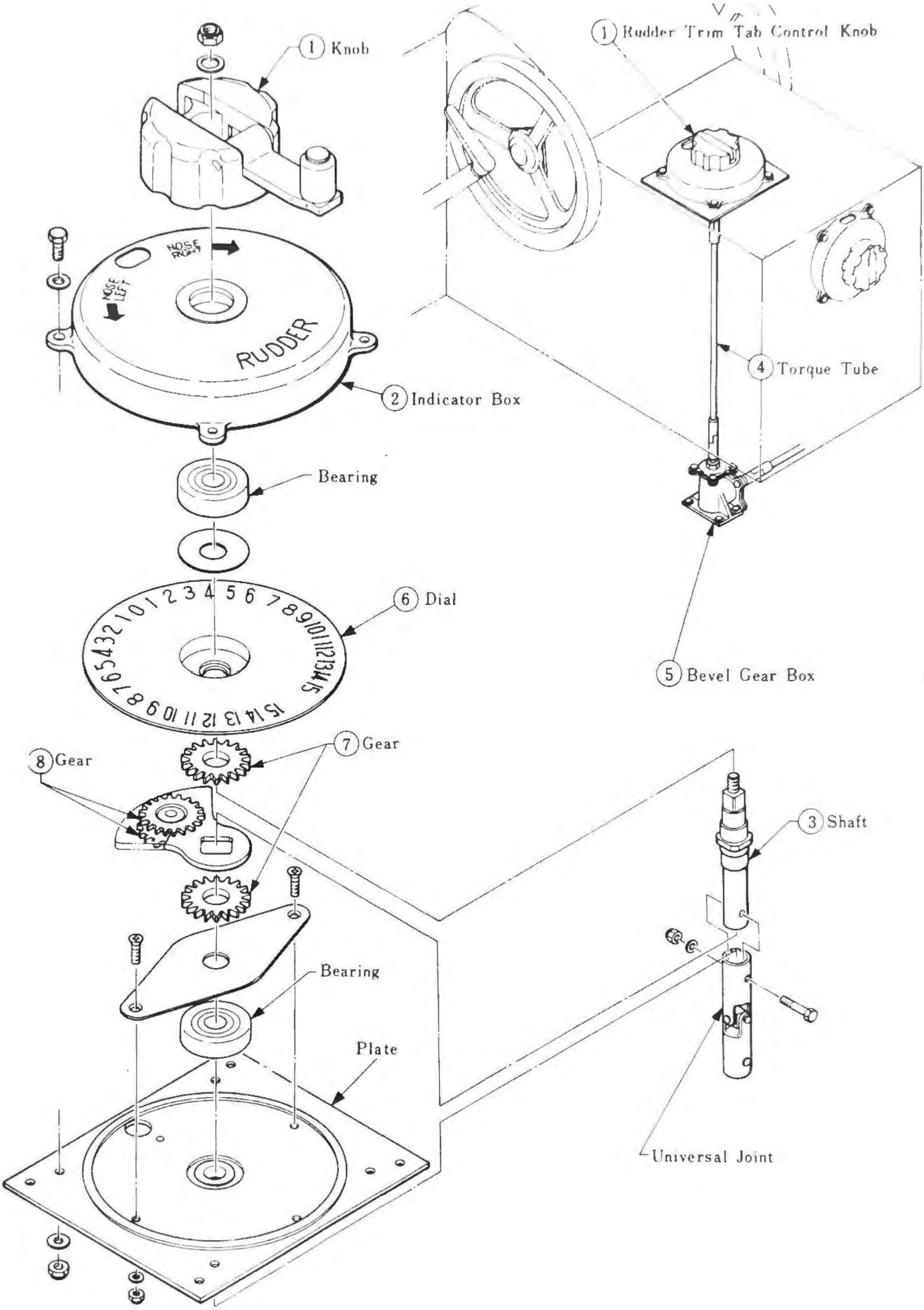
Figure 7–16



Ruder Trim Tab Rigging
Figure 7-17



Rudder Trim Tab Actuator
Figure 7–18



Rudder Trim Tab Indicator
Figure 7–19

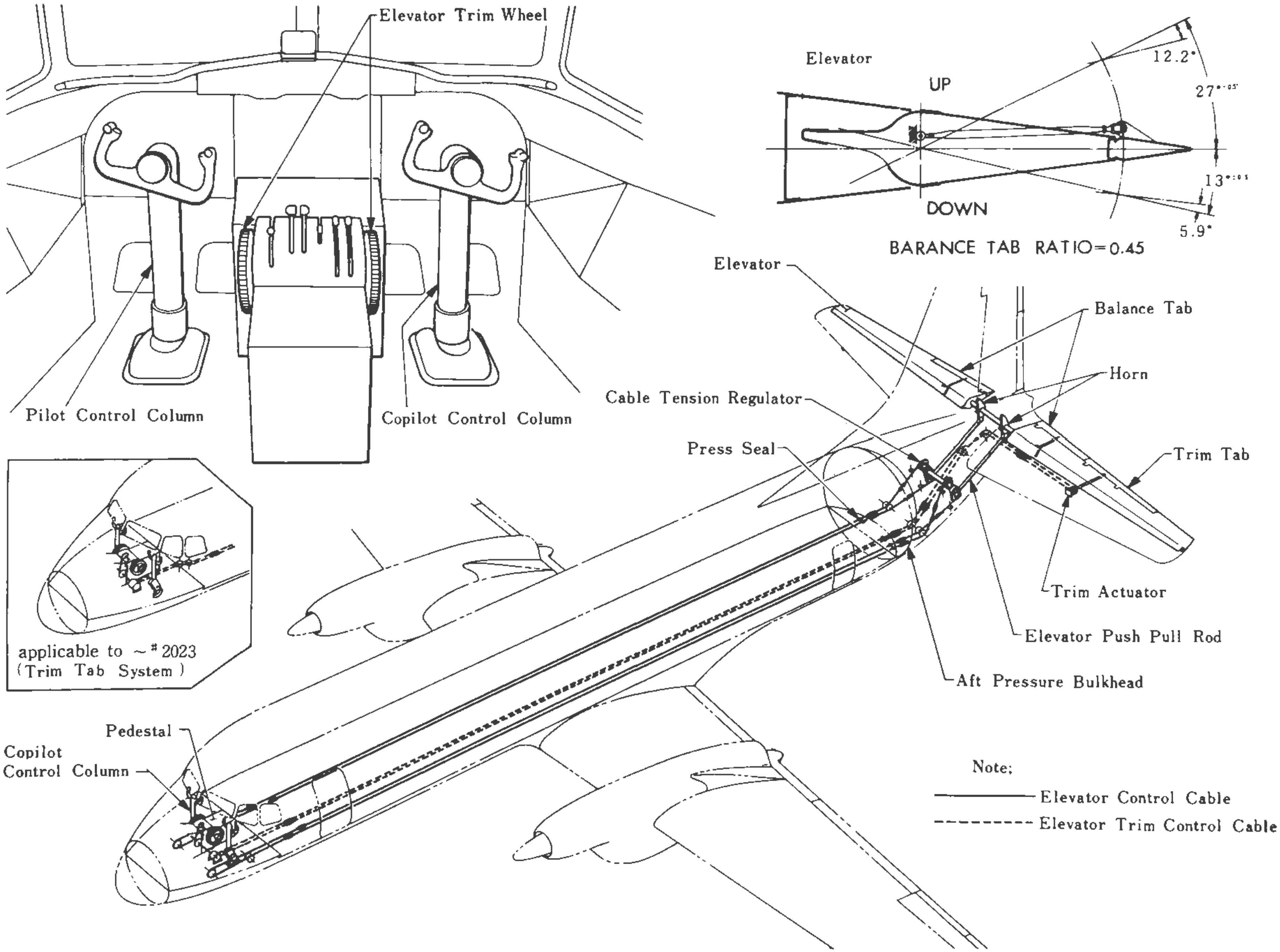
7.6 Elevator Control System

7.6.1 Attachment of Elevator (See Fig. 7-22)

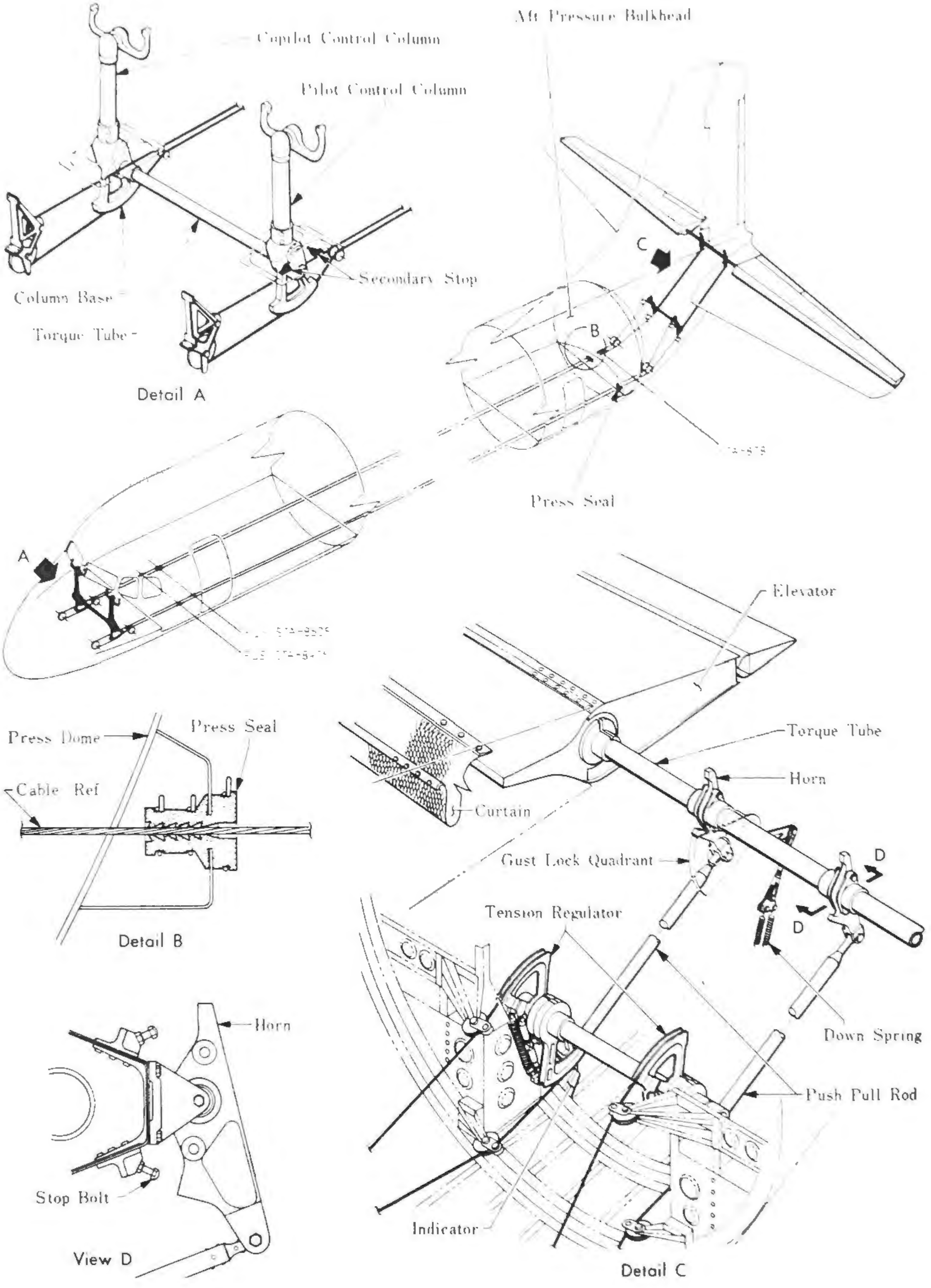
The elevator is attached to the support fittings on the rear spar of the horizontal stabilizer with self aligning roller bearings of 4 hinges. The L.H. and R.H. elevators are connected together with a torque tube.

7.6.2 Elevator Control System (See Figs. 7-20 and 7-21)

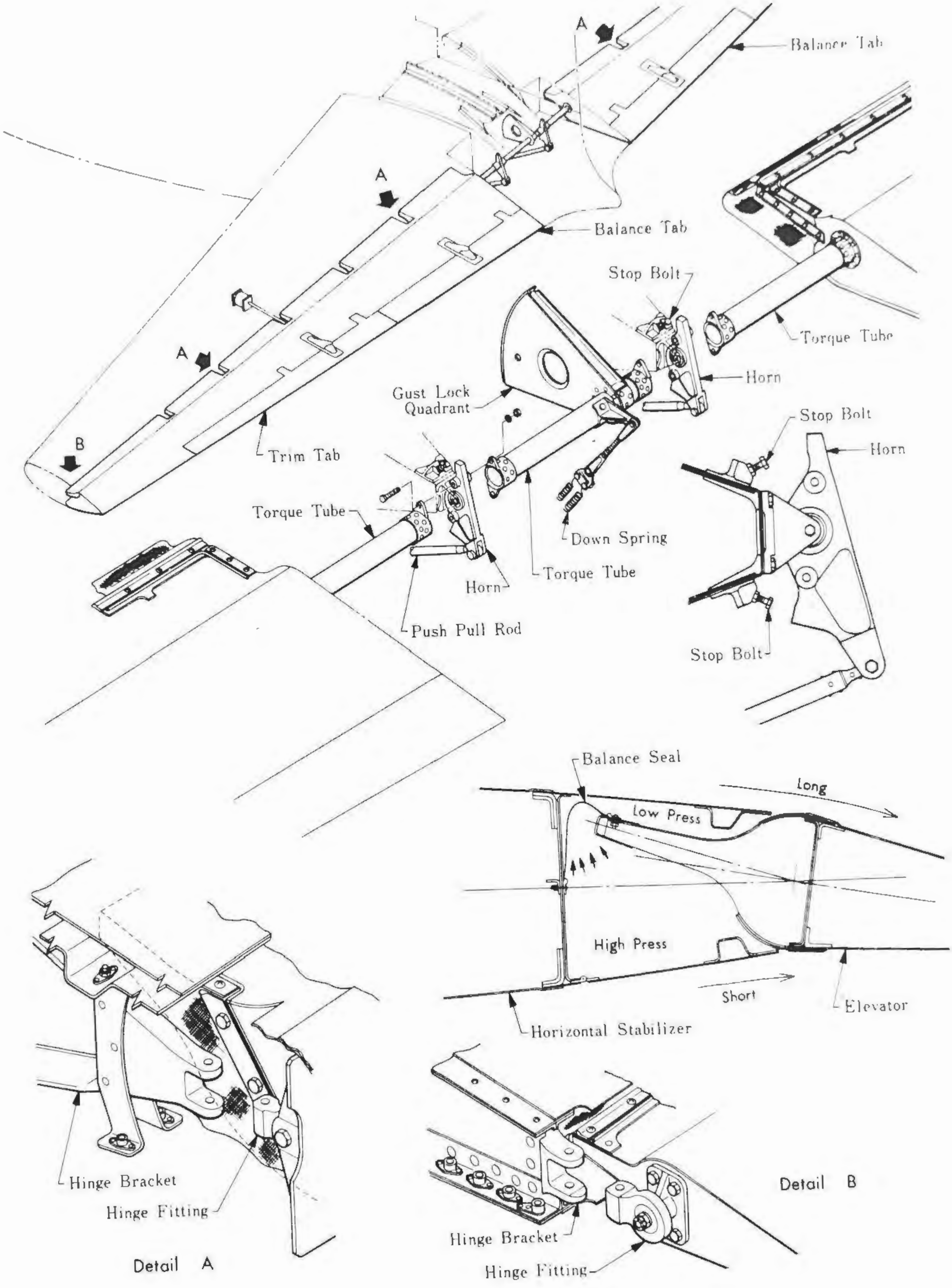
The elevator can be controlled by pushing or pulling the control column in the cockpit. The control columns for the pilot and co-pilot are connected together under the floor with a torque tube and on the root of each column is attached a quadrant. A cable from the quadrant passes the weight reducing holes of the floor beams and is connected to the quadrant with a tension regulator at Fus. Sta 10585 in the aft fuselage through pulleys. Quadrants with tension regulators are provided 1 ea. (2 in all) on the L.H. and R.H. sides, connected together with a torque tube. The arms on the L.H. and R.H. quadrants and the horn fittings on the torque tube which connects the L.H. and R.H. elevators are connected with push-pull rods through which the control signals from the cockpit are transmitted to the elevators.
On the elevator torque tube is installed the down spring.



Elevator and Tab System
Figure 7-20



Elevator Control System
Figure 7-21



Elevator
Figure 7–22

7.6.3 Elevator Cable Tension Regulator (See Figs. 7-23 and 7-24)

Its structure is somewhat different from that of rudder control system but it works on the same principle.

In the regulator unit are provided the rotating shaft and brake. The rotating shaft has a disc in its center and threads on both ends, opposite in direction each other.

Retention of Control Cable Tension

When an equal force is applied to the quadrant, the rotating bolt is rotated and the quadrant rotates and moves, but the torque tube does not rotate.

Elevator Control

If a one sided force is applied to the quadrant, the center disc comes in close contact with the brake, not rotating, and, consequently, the torque tube is rotated through the regulator unit shaft.

7.6.4 Elevator Balance Tab (See Figs. 7-25 and 7-26)

The balance tab is attached to the trailing edge of the elevator with three hinges. The push-pull rod for the balance tab mechanism is connected to the tab horn fitting at H.Sta 1400 and the bracket of the elevator hinge fitting.

If the elevator is controlled, the balance tab is moved against the direction of the elevator by the rod.

7.6.5 Stoppers of System and Functions (See Fig. 7-28)

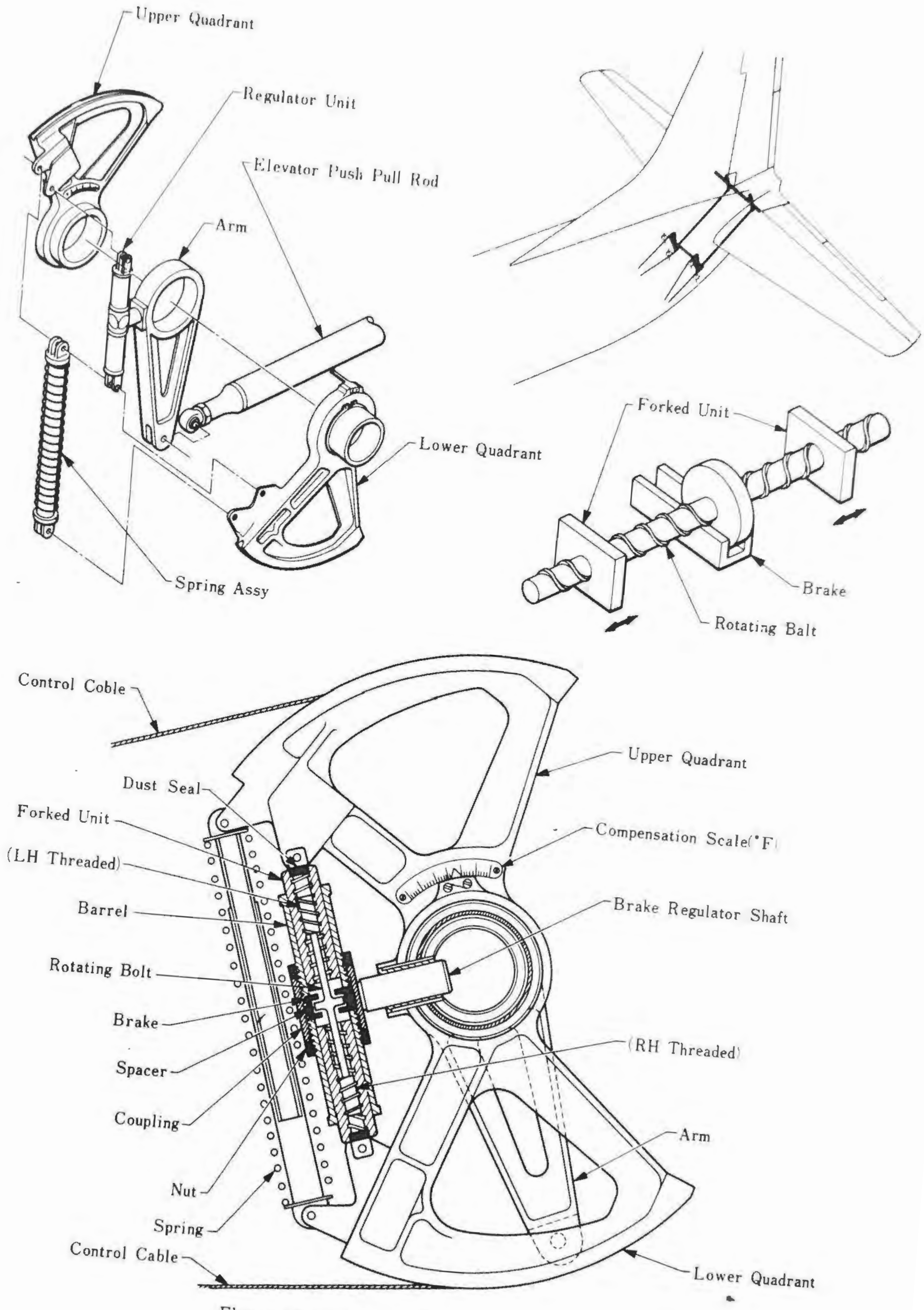
Two stoppers are provided for the elevator control system.

(1) Elevator stopper

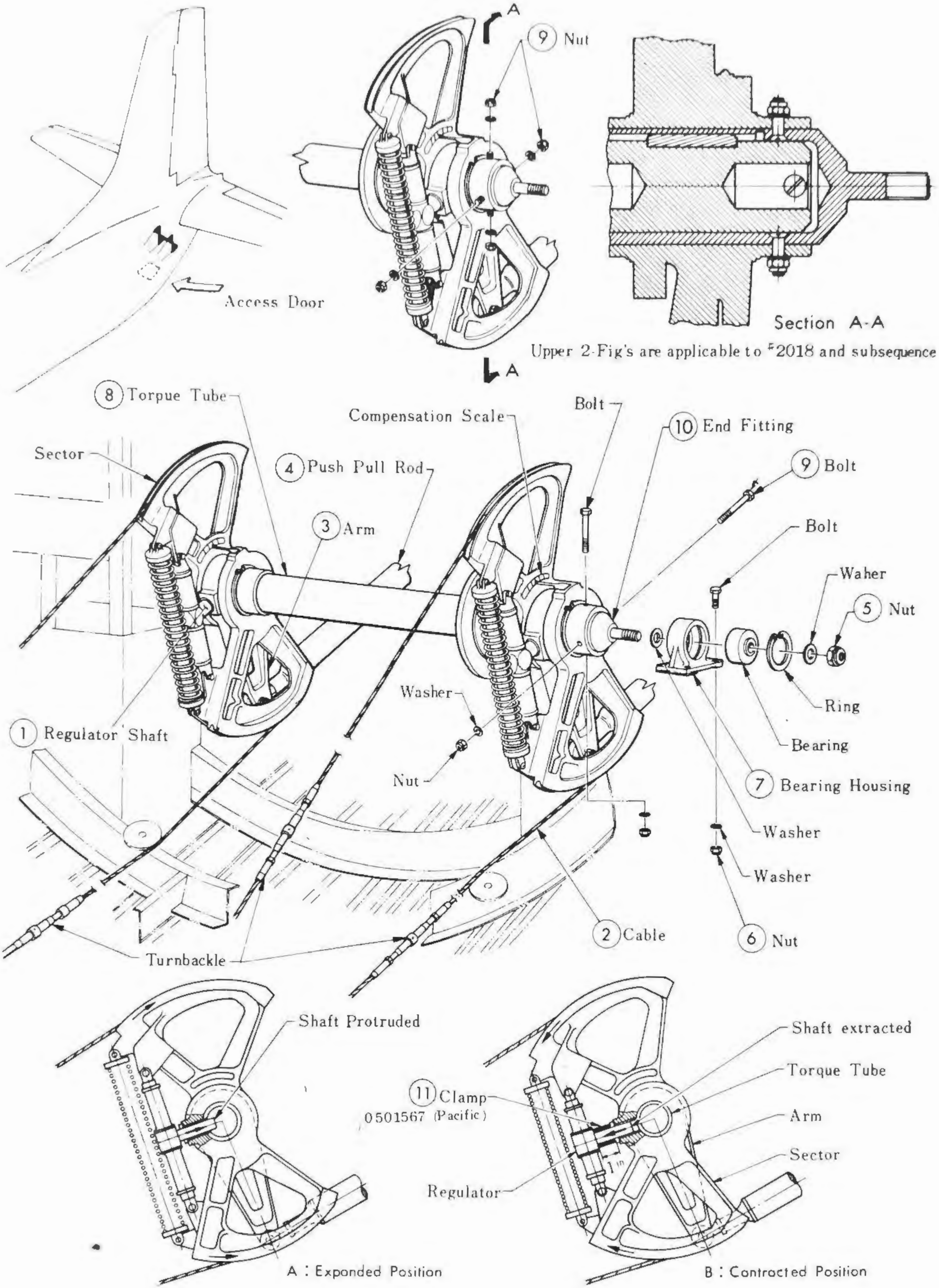
(2) Control column stopper

(1) has an elevator stop bolt on the trailing edge of the horizontal stabilizer with which the horn fitting comes in contact. This restricts the elevator travel angle.

(2) is located on the lower part (above the floor) of the control column to protect the system.

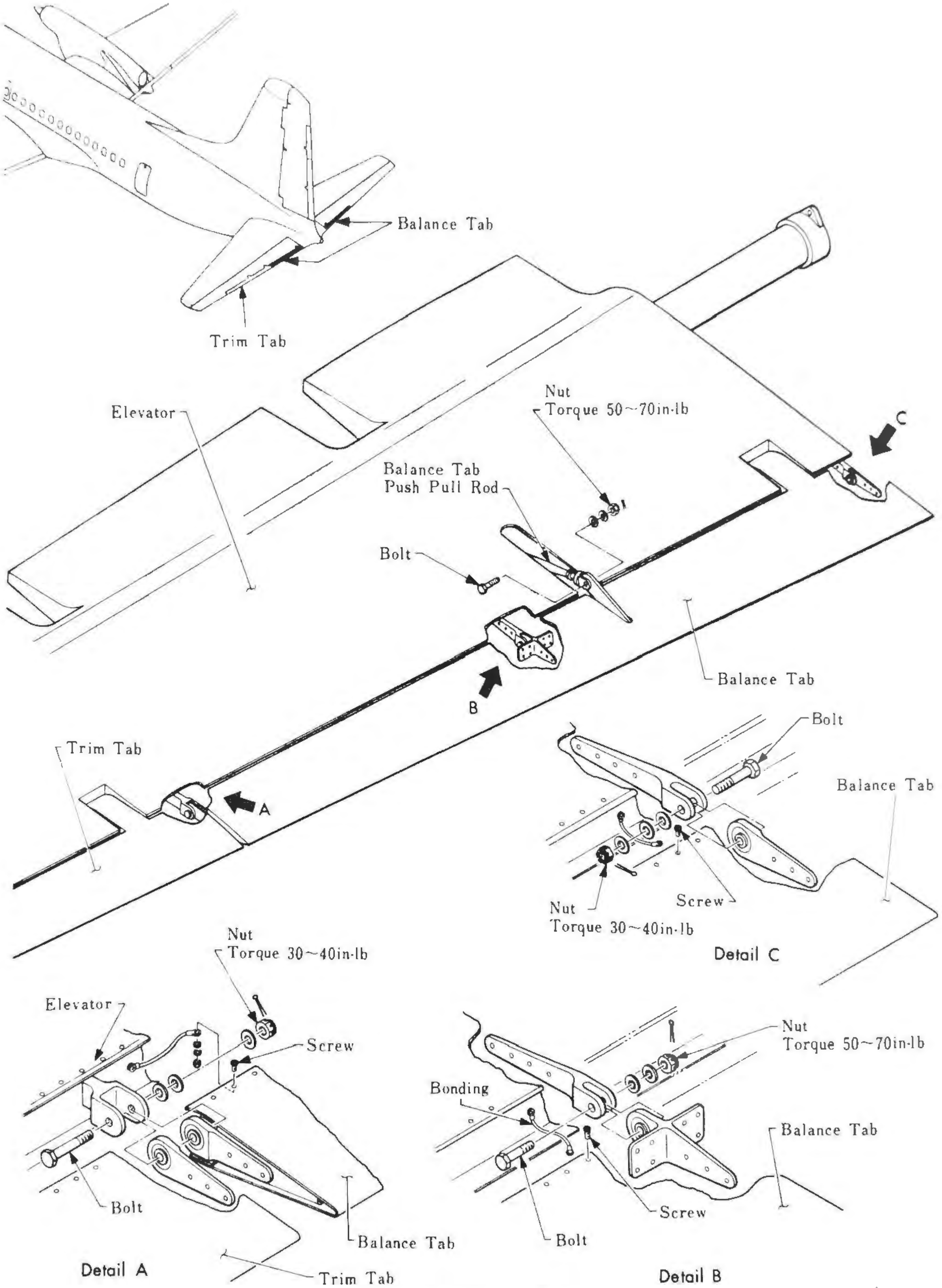


Elevator Control Cable Tension Regulator
Figure 7–23



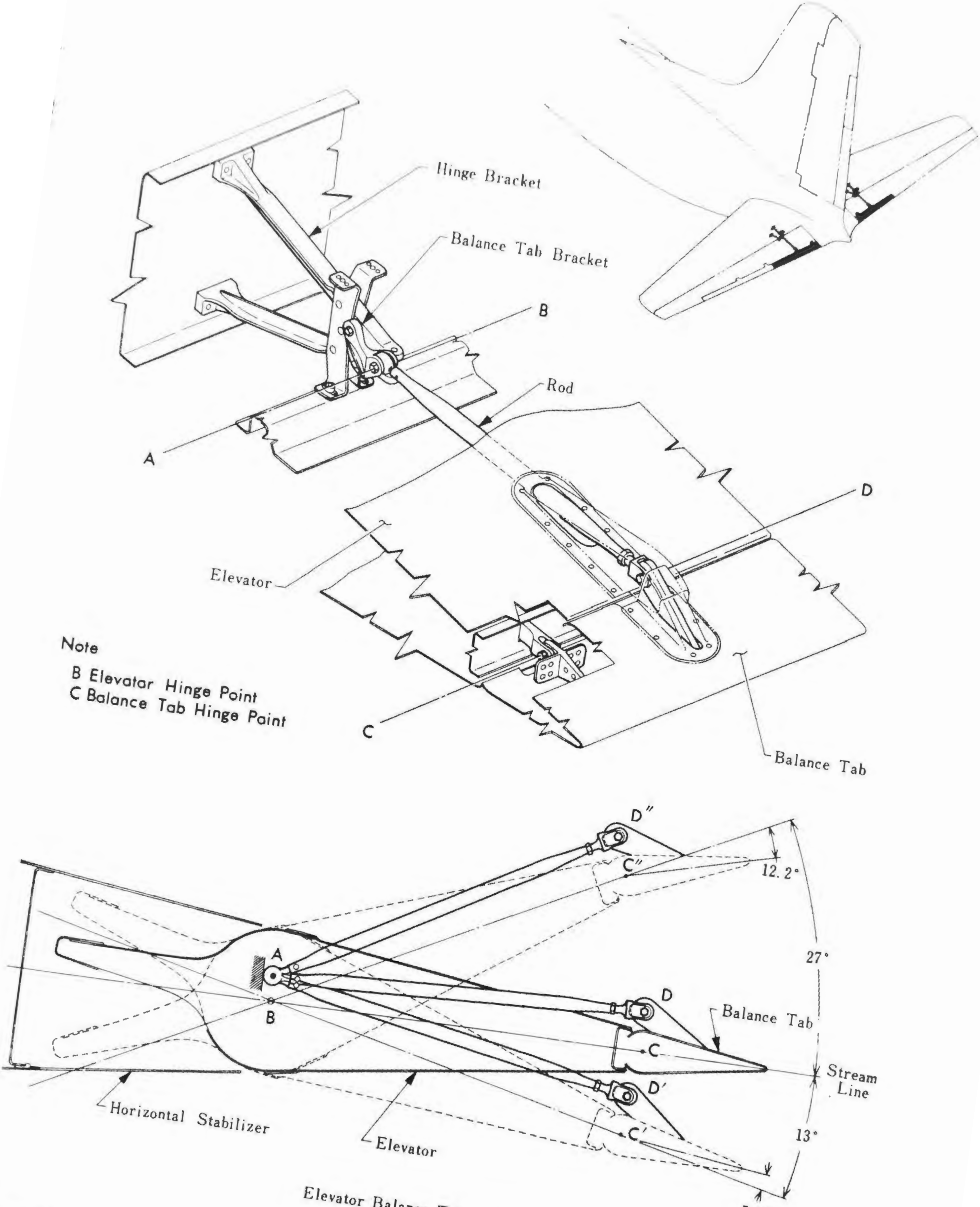
Elevator Tension Regulator Remove Installation

Figure 7-24

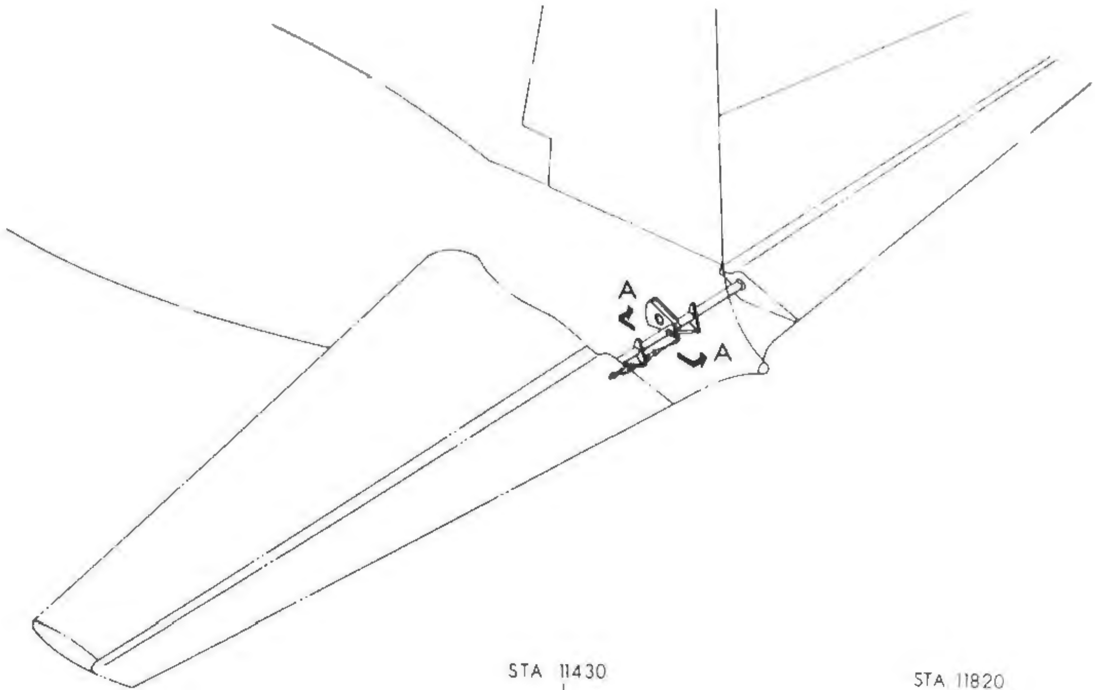


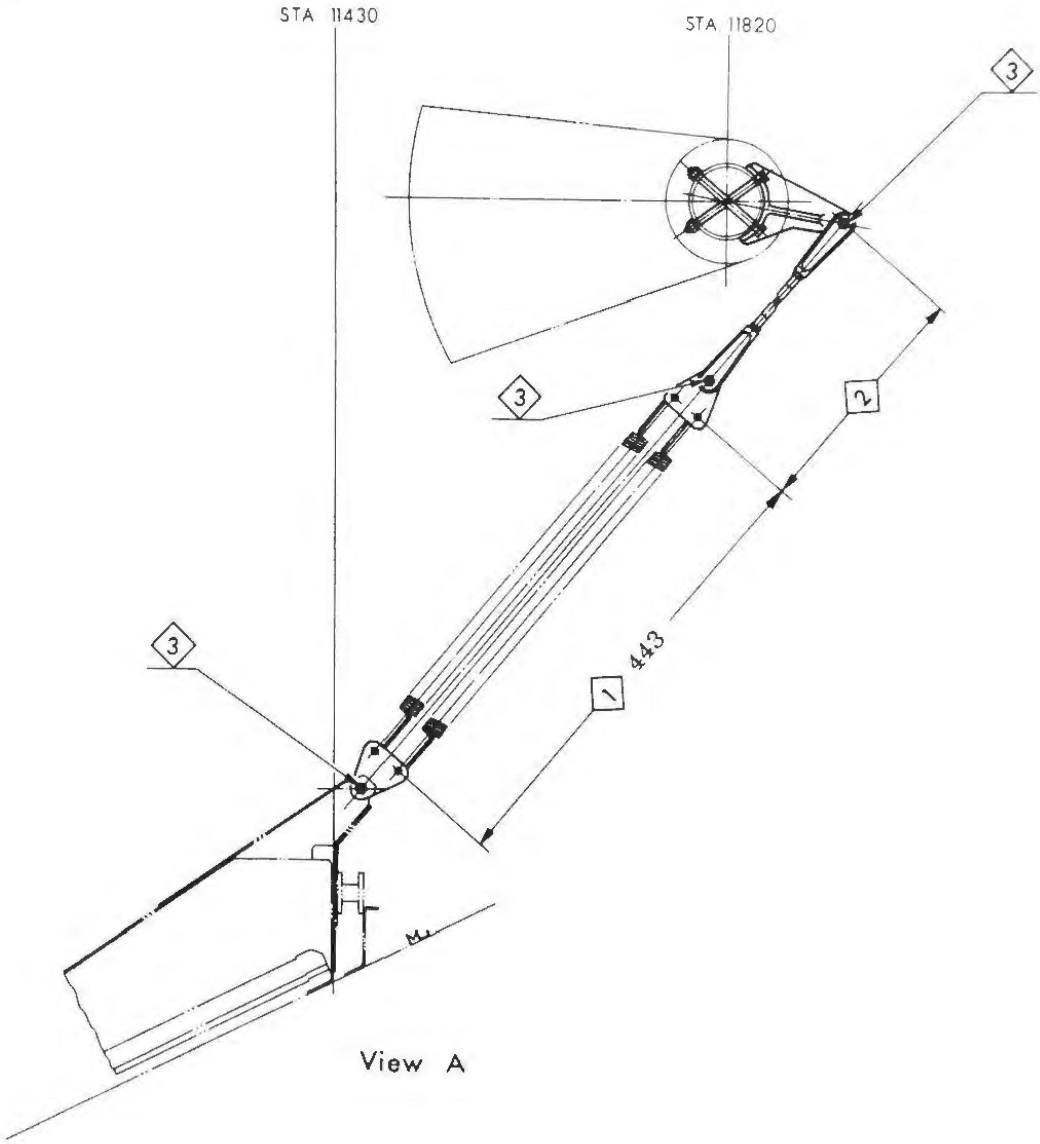
Elevator Balance Tab Hinge

Figure 7–25



Elevator Balance Tab System
Figure 7–26





View A

Elevator Down Spring
Figure 7–27

7.6.6 Procedures for Balance Tab System Adjustment (See Fig. 7-28)

(1) Neutral fixed points of system (3 locations)

Number	Fixed to	Location	Fixing method
1	Control column	Control column	Rigging tool
2	Quadrant with tension regulator	Quadrant	Match the arm mark.
3	Elevator	Torque tube	Gust lock "ON"

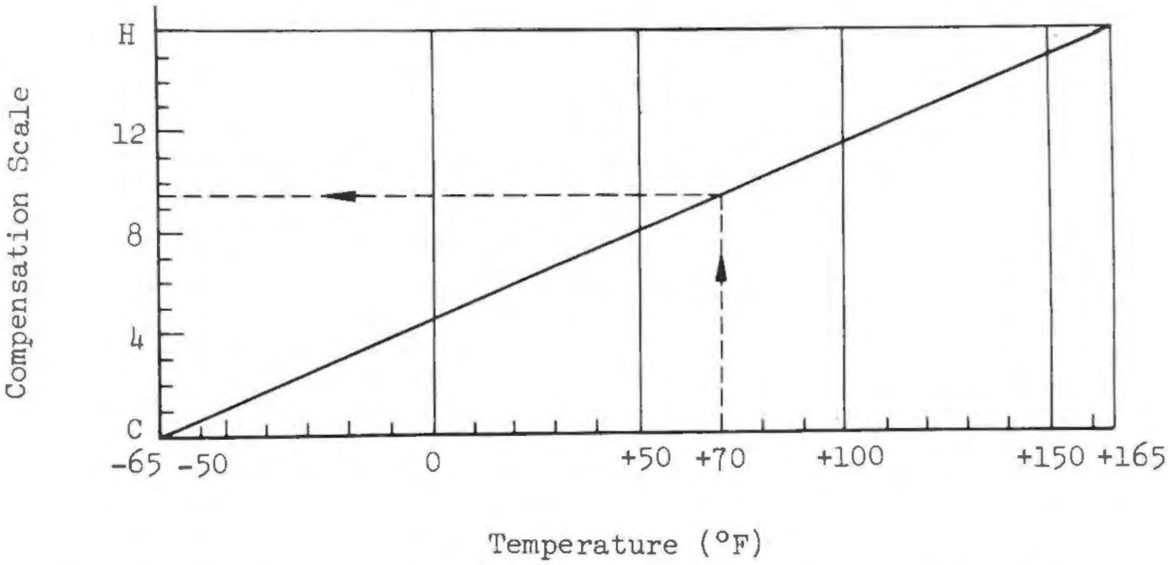
(2) Adjusting procedures

A. Fix number 1.

B. Fix number 3.

C. Adjust the push-pull rod so that the arm mark of the quadrant with a tension regulator, number 2, is lined up to the mark on the frame at Fus. Sta. 10585.

D. Tighten the cable. For the tension, see the compensation scale for the regulator.

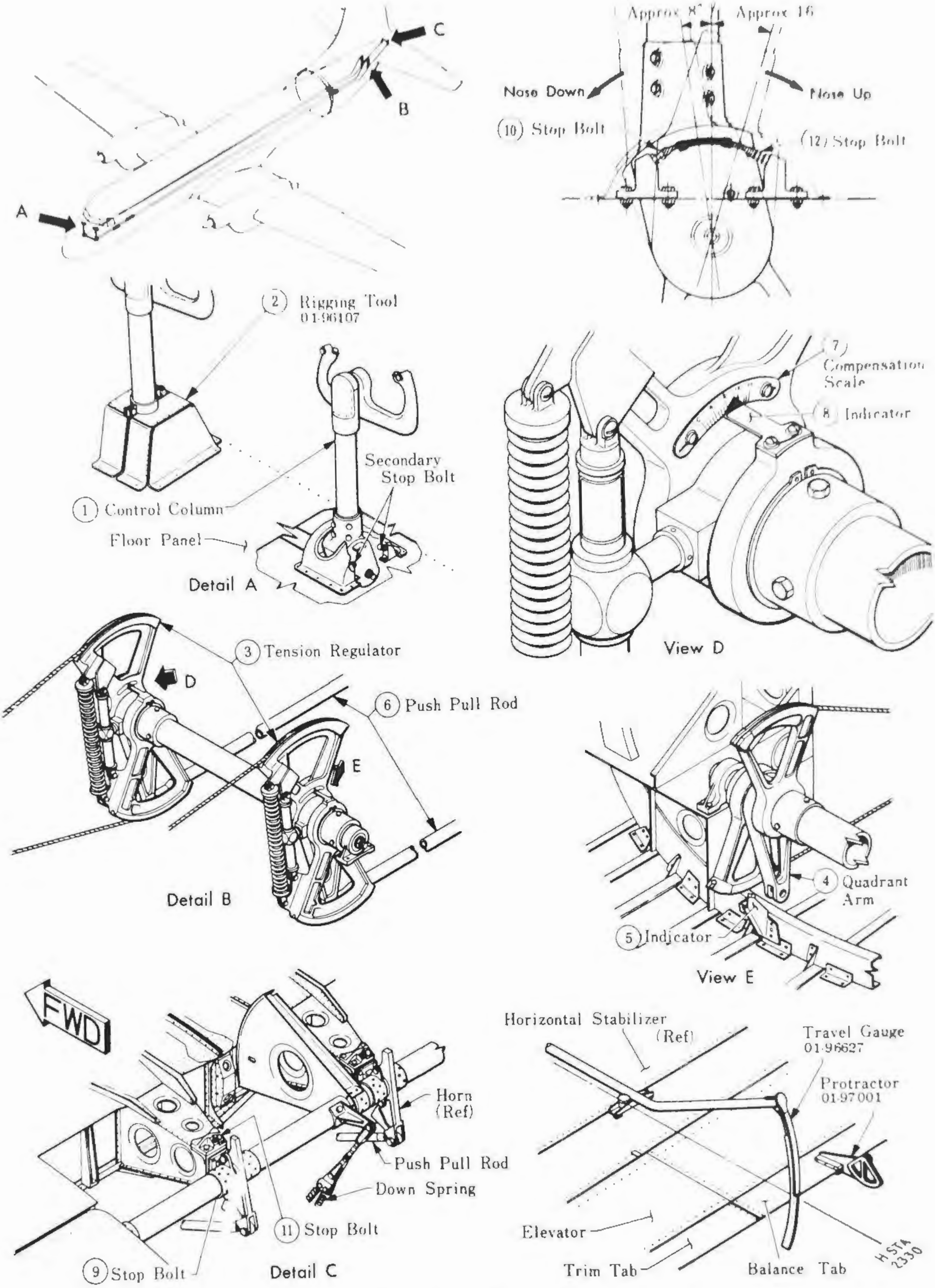


E. Fix the control surface at its neutral position with number 3 and adjust the tab, setting the tab to 0° with a contour gauge.

Adjustment of Stopper

F. Adjust the stop bolt for the elevator using a contour gauge so that the elevator can be controlled within the specified angle range.

G. Adjust the stop bolt for the control column so that the column comes in contact with the stopper when 55 Kg ± 1 Kg force is applied to the column center after the stopper mentioned in F comes in contact.



Elevator Control System Rigging

Figure 7–28

7.7 Elevator Trim Tab Control System

7.7.1 Attachment of Trim Tab (See Fig. 7-29)

The trim tab is attached to the hinge brackets of the elevator with four hinges. On the horn fitting on the front spar of the trim tab is located a push-pull rod connected to the trim actuator.

7.7.2 Trim Tab Control System (See Fig. 7-30)

The elevator trim tab can be controlled by rotating the elevator trim tab control wheel on the center pedestal in the cockpit.

The rotation of the control wheel is transmitted to the cable drum by chains. A cable from the cable drum passes the weight reducing holes of the floor beams, reaches the aft fuselage, bends up at a pulley at Fus. Sta 9480 and transmits the rotation of the control wheel to the screw jack type actuator installed at H.Sta 3000. The actuator actuates the trim tab through the push-pull rod.

7.7.3 Indicator Box (See Fig. 7-31)

On the center pedestal is provided the indicator box which indicates the amount of the elevator trim control.
The rotation of the trim control wheel which can be rotated forward by 0.93 turns and rearward by 0.94 turns, is reduced by the reduction gears and the indication is shown on the dial with graduations marked on the face.

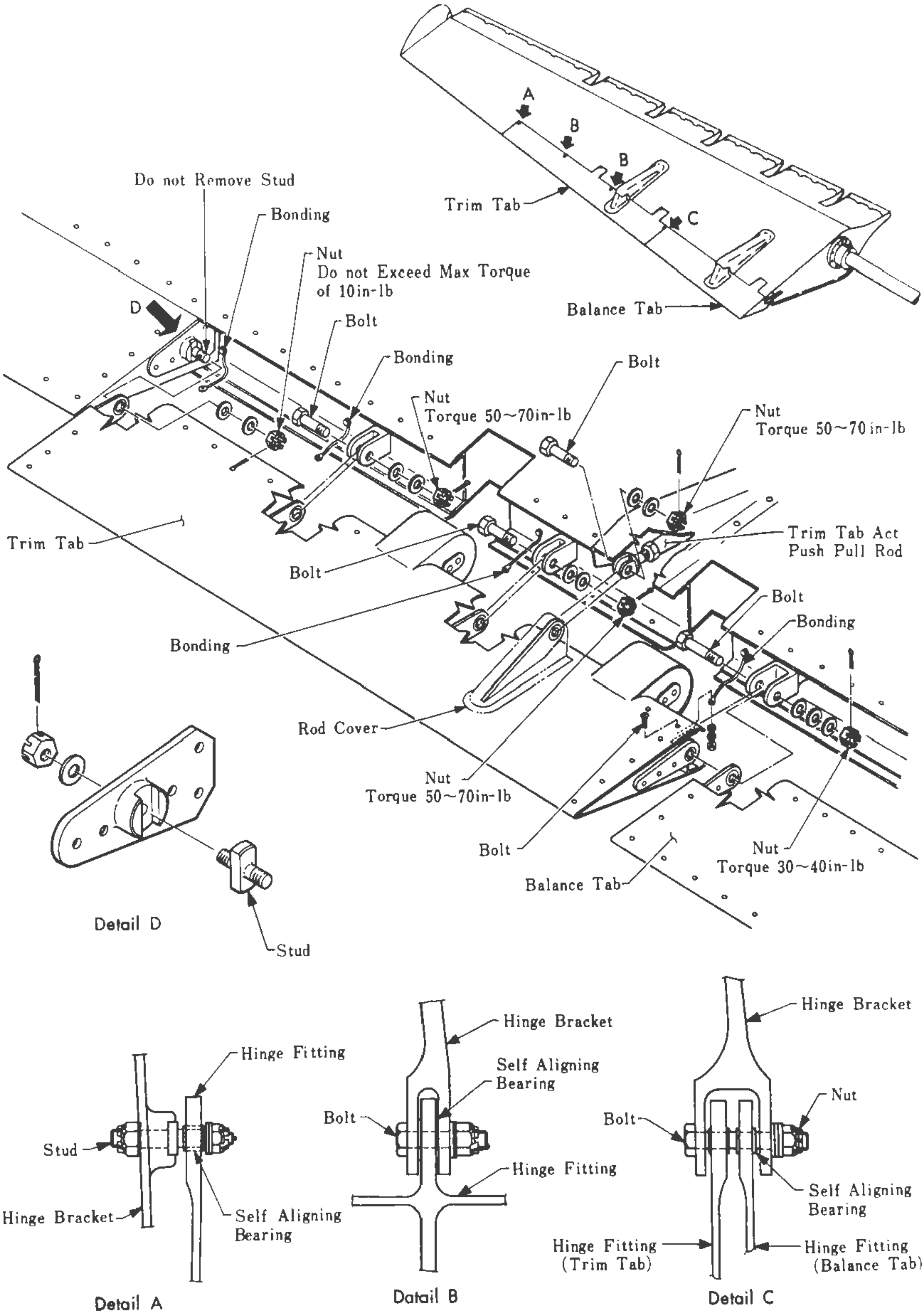
Graduations of Indicator

Rotation of Knob	Indication	Tab Position	Maximum Scale
Forward	Red	Up	10
Rearward	Black	Down	15
0 position	Green	0	-

7.7.4 Procedures for Trim Tab System Adjustment (See Fig. 7-30)

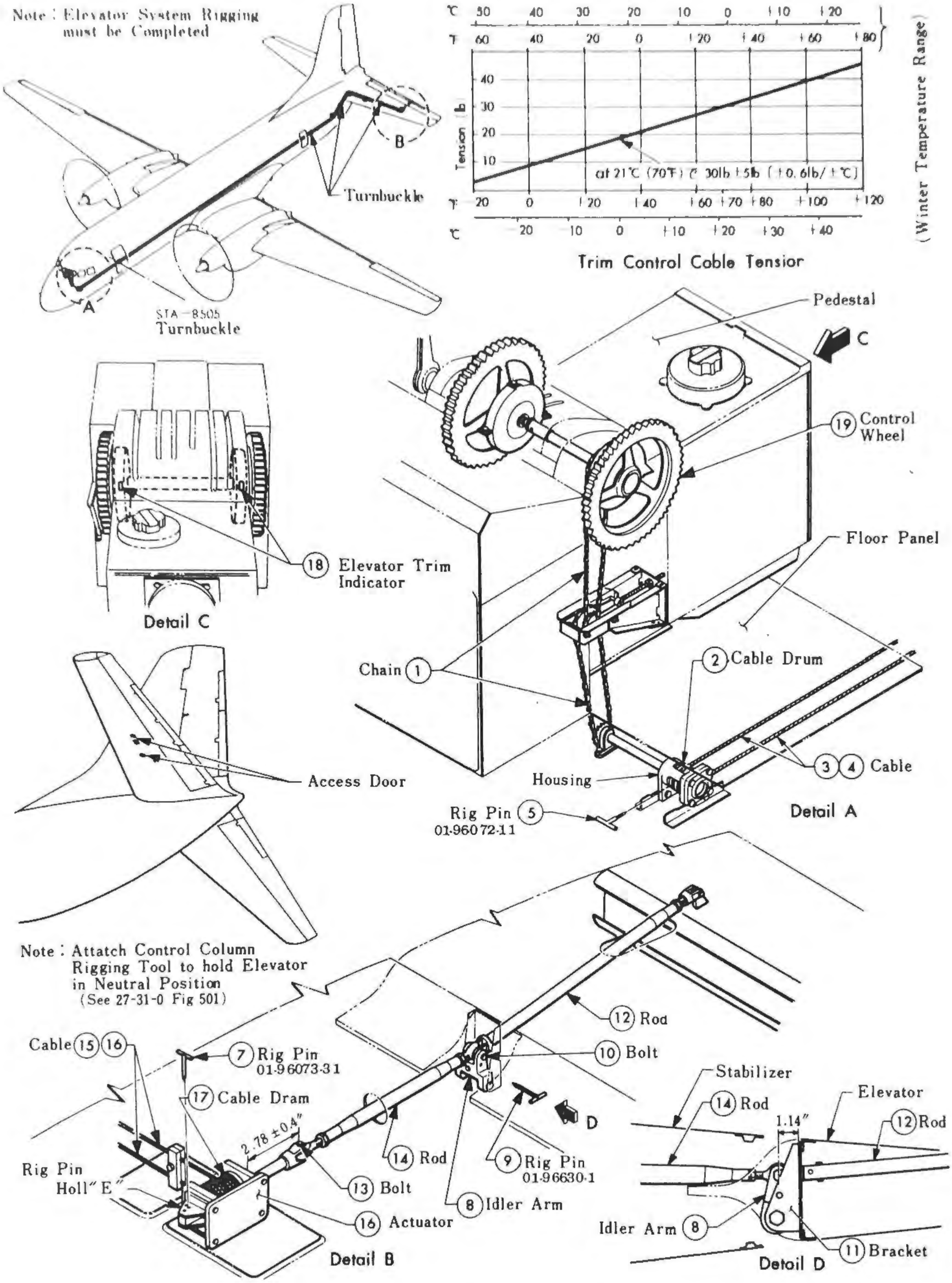
(1) Neutral fixed points of system (3 locations)

Number	Fixed to	Location	Fixing method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Trim actuator	Rigging pin
3	Push-pull rod	Idle arm	Rigging pin



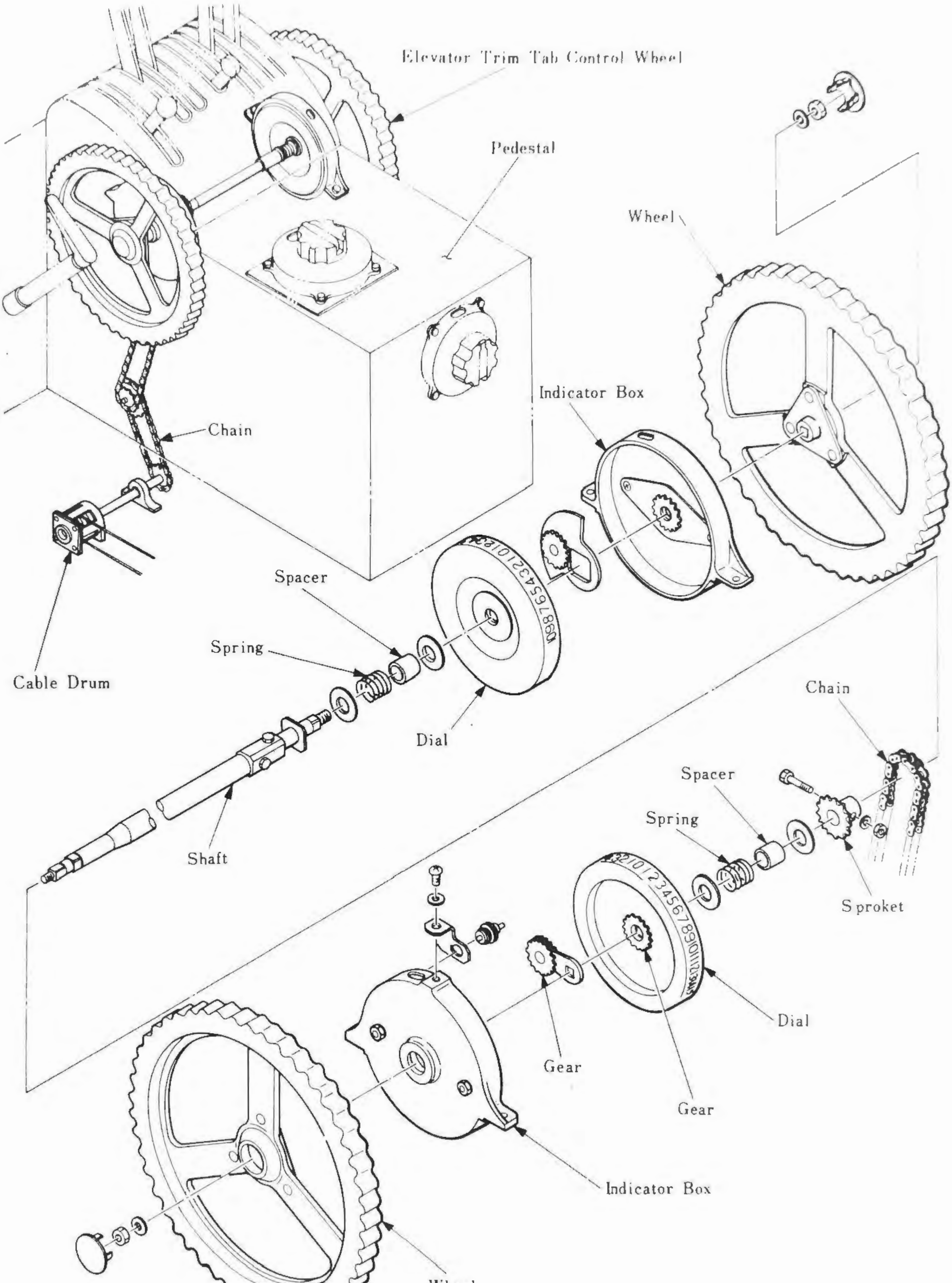
Elevator Trim Tab Hinge

Figure 7–29



Elevator Trim Tab Control System Rigging

Figure 7–30



Elevator Trim Indicator
Figure 7–31

(2) Adjusting Procedures

A. Fix numbers 1, 2 and 3.

B. Fix the elevator and the trim tab at neutral positions.

C. Adjust the push-pull rod.

D. Tighten the cable. The cable tension should be 30 ± 5 lb (±0.4 lb/°F) at 70°F.

Adjustment of Stopper

E. The stopper for the trim tab system is built in the indicator box. The stopper comes in contact if the control wheel is rotated to the full and it can not be moved any further.

7.8 Flap Control System

7.8.1 Attachment of Flap (See Figs. 7-32 and 7-34)

The flaps are of Fowler type and the inboard flap is attached to W.Sta 0 to 4800 and the outboard flap to W.Sta 4800 to 9517 for each wing.

On each flap are attached 2 sets of drag links and 3 sets of carriages. These drag links fixed to the flaps with hinges, are attached to the nut of the actuator screw jack with 4 bolts. Each carriage has 5 sets of rollers (8 ea.) holding ⊥ shape of the track(rail attached on the wing structure from the top, bottom, left and right sides.

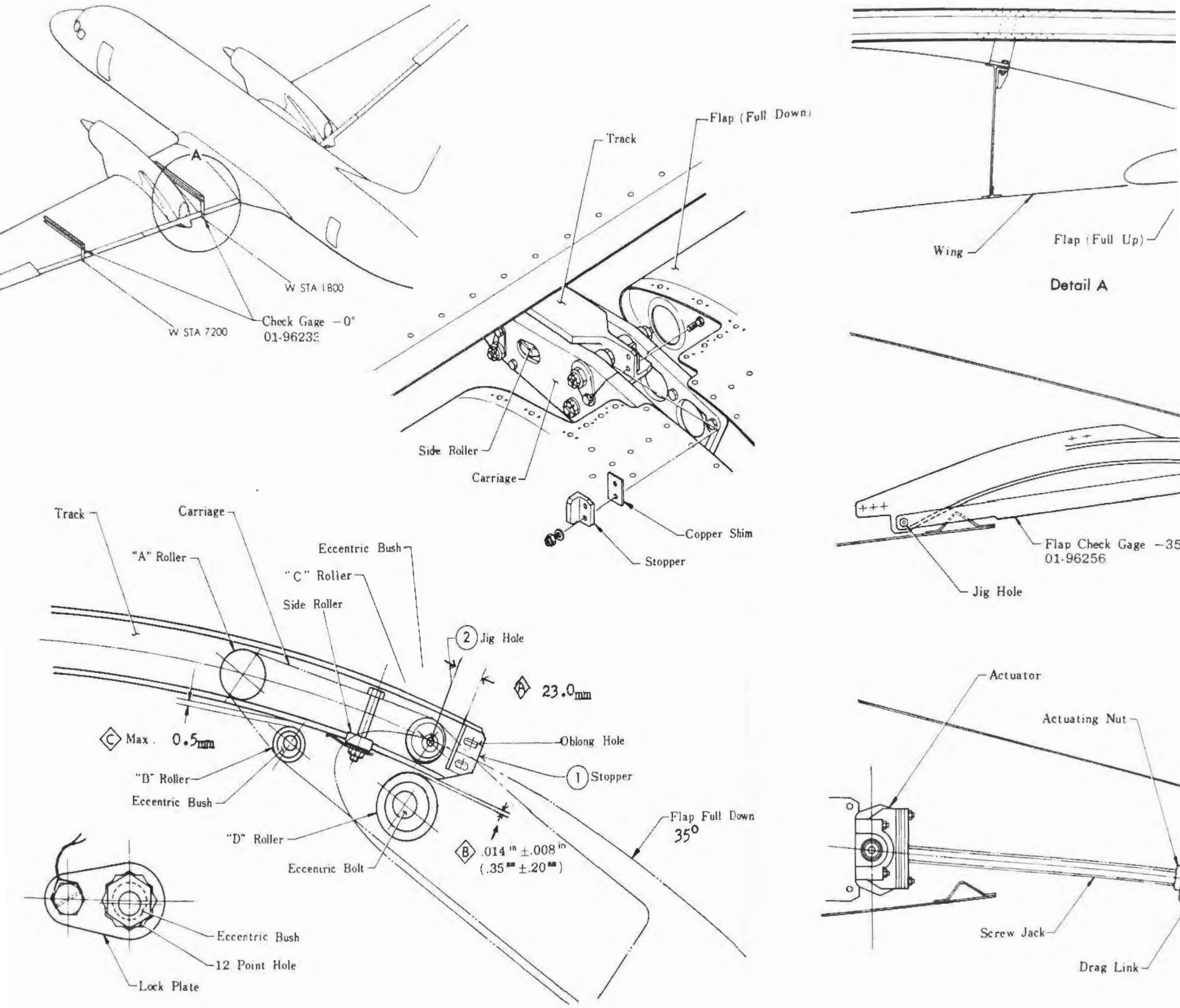
The flap is actuated hydraulically and controlled electrically, being driven by screw jacks.

7.8.2 Flap Control Electrical System (See Fig. 7-33)

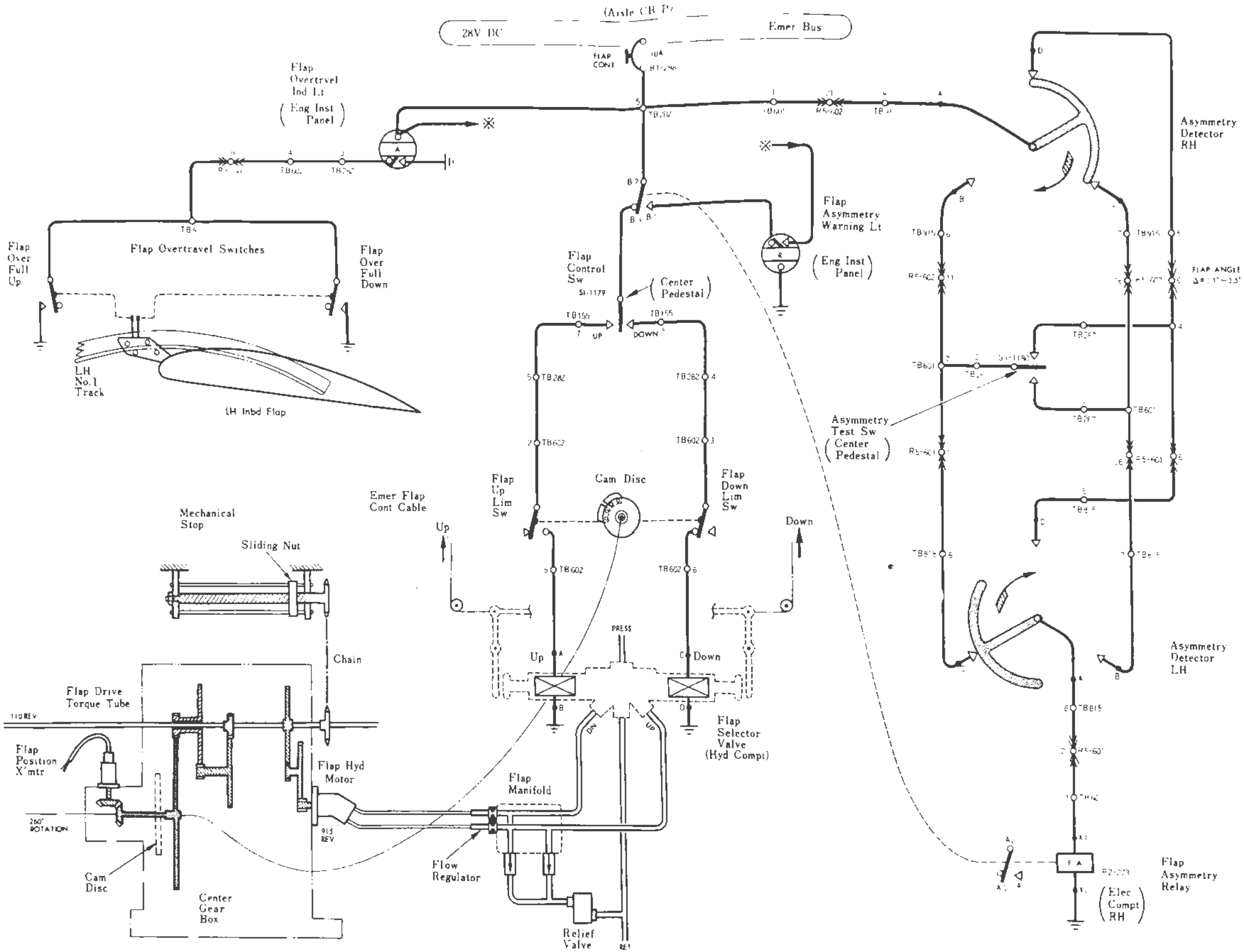
In the hydraulic compartment is provided a flap hydraulic motor which drives the screw jacks. This system consists of simple wiring and three switches since the flap selector valve controlling the flap hydraulic motor is regulated electrically.

(1) Composition

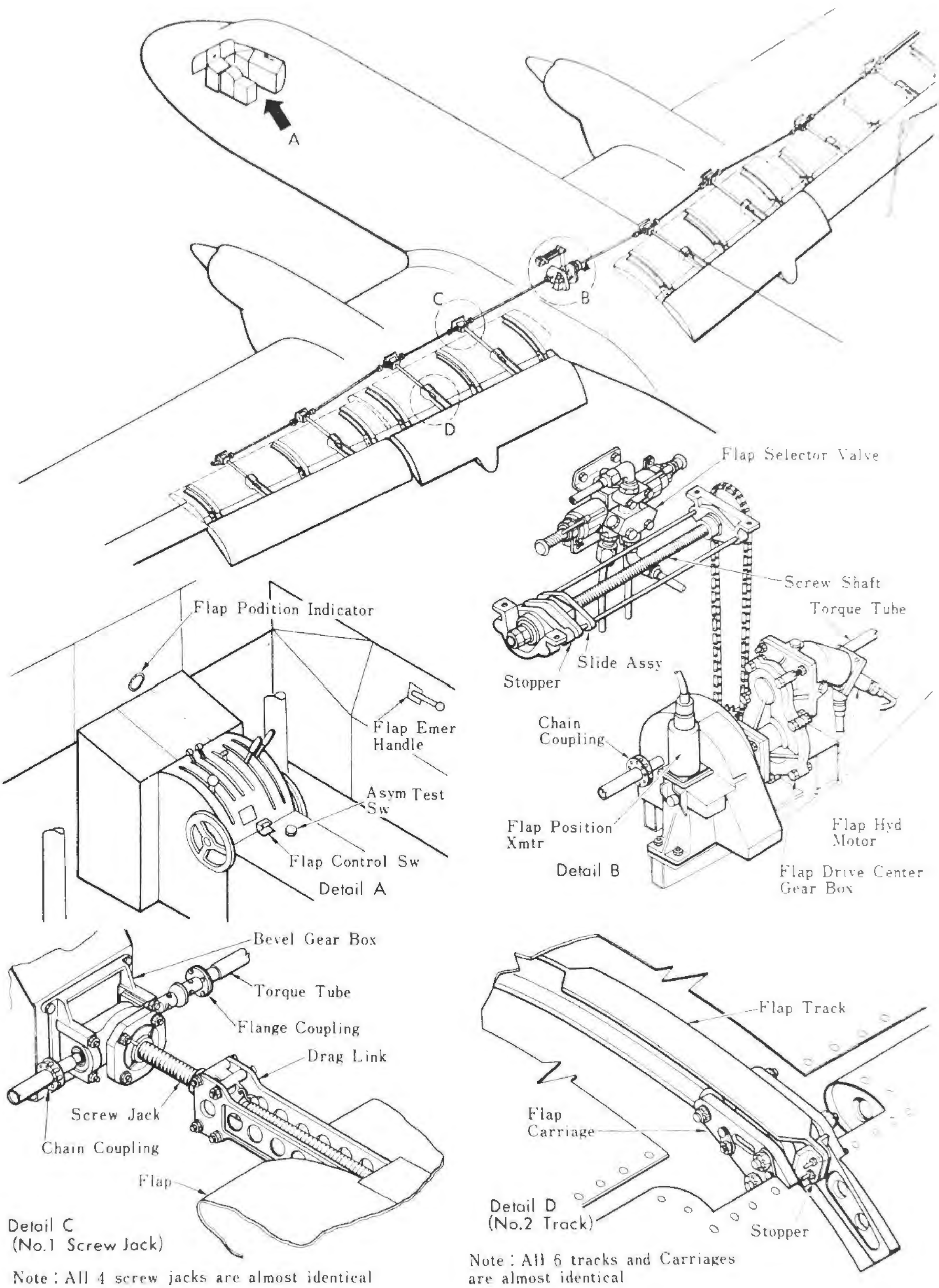
a. Power 28V DC (from the emergency bus)
b. Flap control switch (on the pedestal in the cockpit)
c. Flap limit switch (in the flap center gear box)
d. Flap asymmetry (in the flap well)
e. Flap overtravel (on the track)



Wing Flap Removal/Installation
Figure 7-32



Flap Electric System Schematic
Figure 7-33



Wing Flap System

Figure 7-34

(2) Operation

If the flap control switch is placed in "UP" or "Down," the "UP" side or "Down" side solenoid of the flap selector valve is energized and hydraulic pressure is supplied to the "UP" or "Down" piping, driving the hydraulic motor to rotate the flap drive torque tube through gears and, in turn, move the flap.
If the cam disc rotates as the flap moves, the flap angle reaches 0° or 35°. Then, the flap limit switch is energized, shutting off power supply to the flap selector valve. As the torque tube is connected to the mechanical stop with chains, the flap stops at the mechanical stop if the limit switch is inoperative due to failure or some other reasons. The flap overtravel indicating light beside the flap position indicator on the engine instrument panel comes on.

7.8.3 Flap Hydraulic System (See Fig. 7-35)

This system is provided to drive the flap. Several units have been introduced to maintain the flap driving speeds within reasonable range.

(1) Principal components of Hydraulic System

A. Flap selector valve

B. Flap manifold

C. Flap relief valve

D. Flap hydraulic flow regulator

E. Flap drive hydraulic motor

All the above units are located in the left forward portion of the hydraulic compartment.

(2) Operation of the whole system

Hydraulic pressure from the upstream hydraulic power system passes the selector valve line corresponding to the flap control switch, the manifold and the flow regulator successively, driving the hydraulic motor.

At the same time, the hydraulic fluid is connected to the flap relief valve which regulates the system pressure at 2000 psi. If the switch is turned off, the hydraulic motor is locked.

A. Flap Selector Valve (See Fig. 7-36)

Performance (Sumitomo Precision Industry Co.)

Min.operating pressure	250 psi		
Pressure range	Rating	Press. side	Return side
		3000 psi	1000 psi
	Proof pressure	4500 psi	1500 psi
Operating time	Electric circuit	Close	Within 0.04 sec.
	Electric circuit	Open	Within 0.10 sec.

This is an electro-magnetically operated 4 way valve. Its up and down lines are closed when electric power is not supplied to it. The up and down ports are switched by opening or closing the valve inside electro-magnetically. If hydraulic pressure is not available, the ports are not switched even though electric power is supplied. The emergency flap handle pushes the buttons on the valve mechanically through a cable to drive the flap.

B. Flap Manifold (See Fig. 7-35)

The hydraulic fluid coming from the up or down port of the flap selector valve is divided in this manifold to the flow regulator and the flap relief valve through a check valve.

C. Flap Relief Valve (See Fig. 7-37)

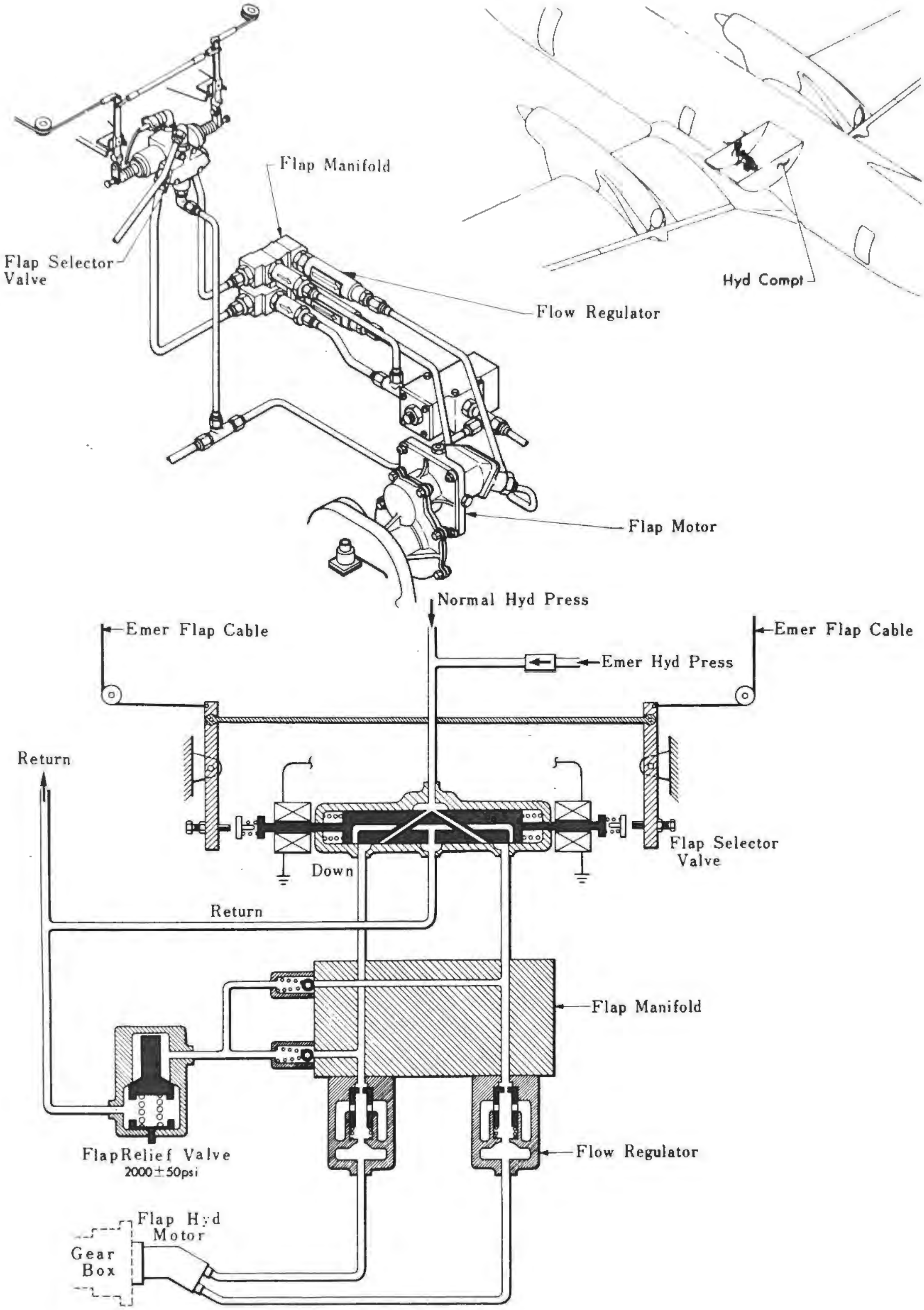
(Teijin Seiki Co.)

The hydraulic fluid divided in the manifold, regulates the flap operating speed, and it is also regulated by the relief valve at 2000^{+50}_{-0} to avoid fast cut-in and cut-out cycle of the unloading valve. The hydraulic oil from the relief valve goes to the return line and the remaining portion goes to the flow regulator.

D. Flap Hydraulic Flow Regulator (See Fig. 7-38)

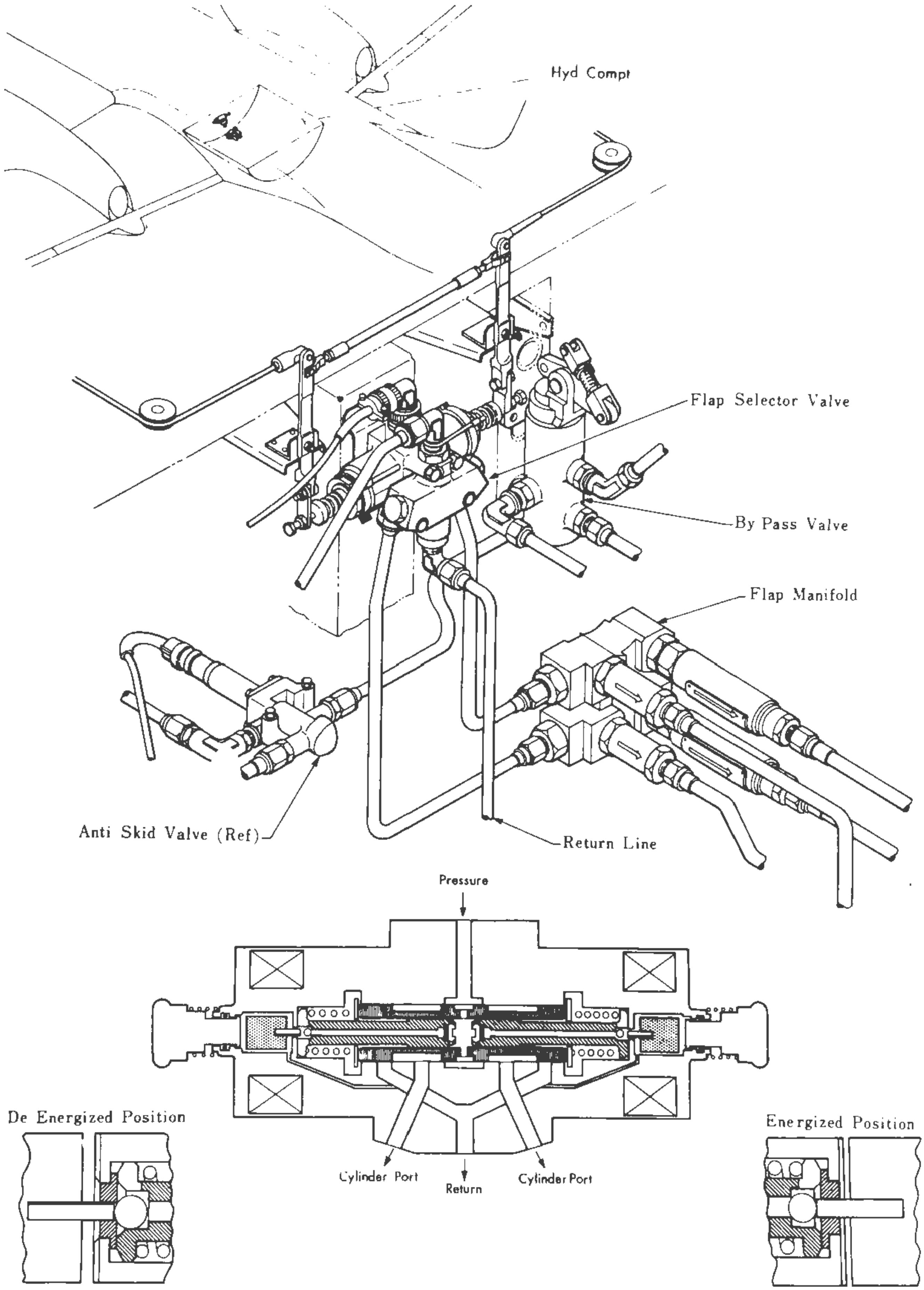
(Teijin Seiki Co.)

In the up line and the down line of the flap manifold outlet are provided the flow regulators of the same type, 1 ea. The hydraulic pressure of this flow regulator is above 70 psi, the flow being regulated at 1.75 GPM in the down side and 1.5 GPM in the up side. The hydraulic fluid thus regulated flows into the hydraulic motor.

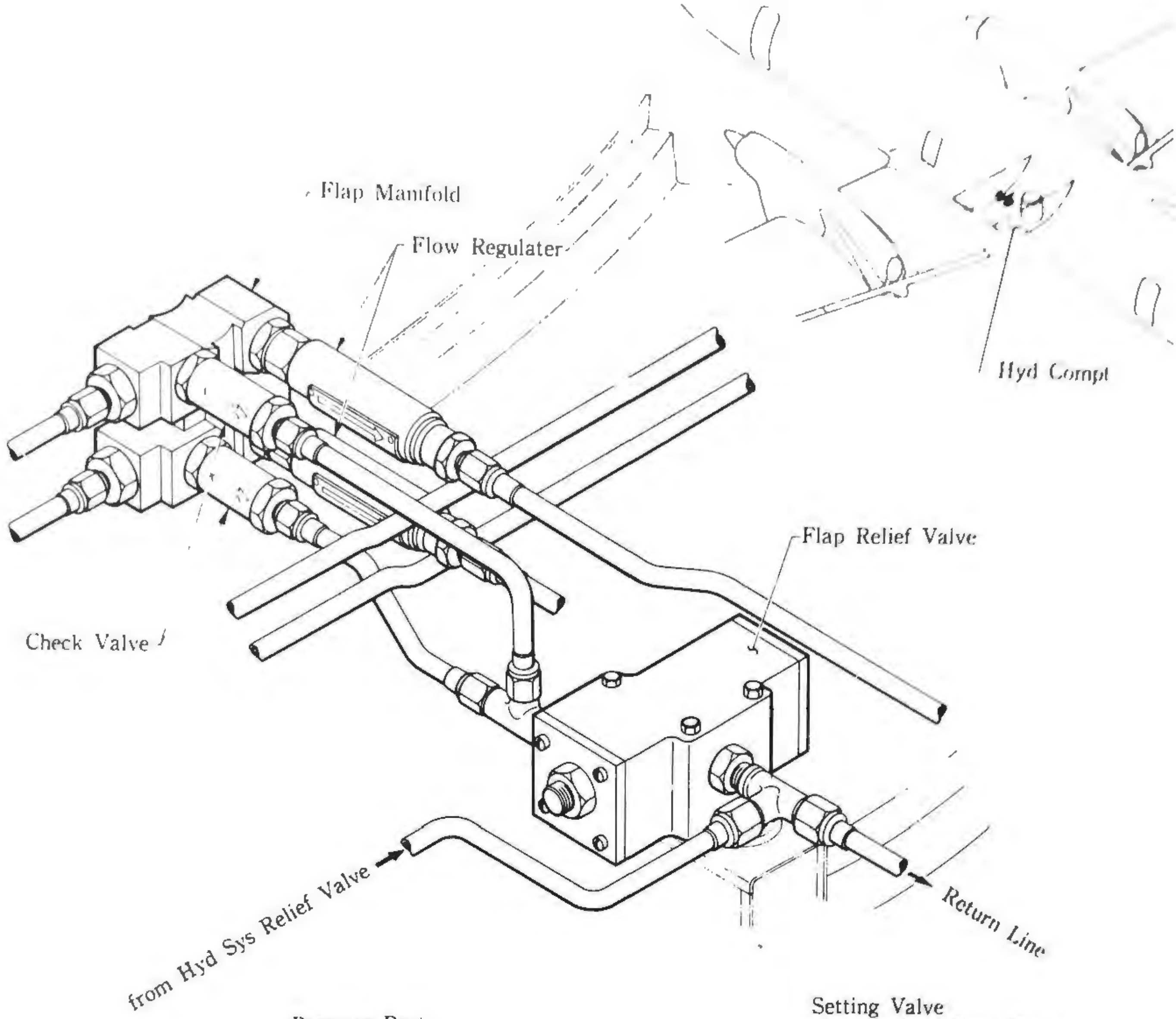


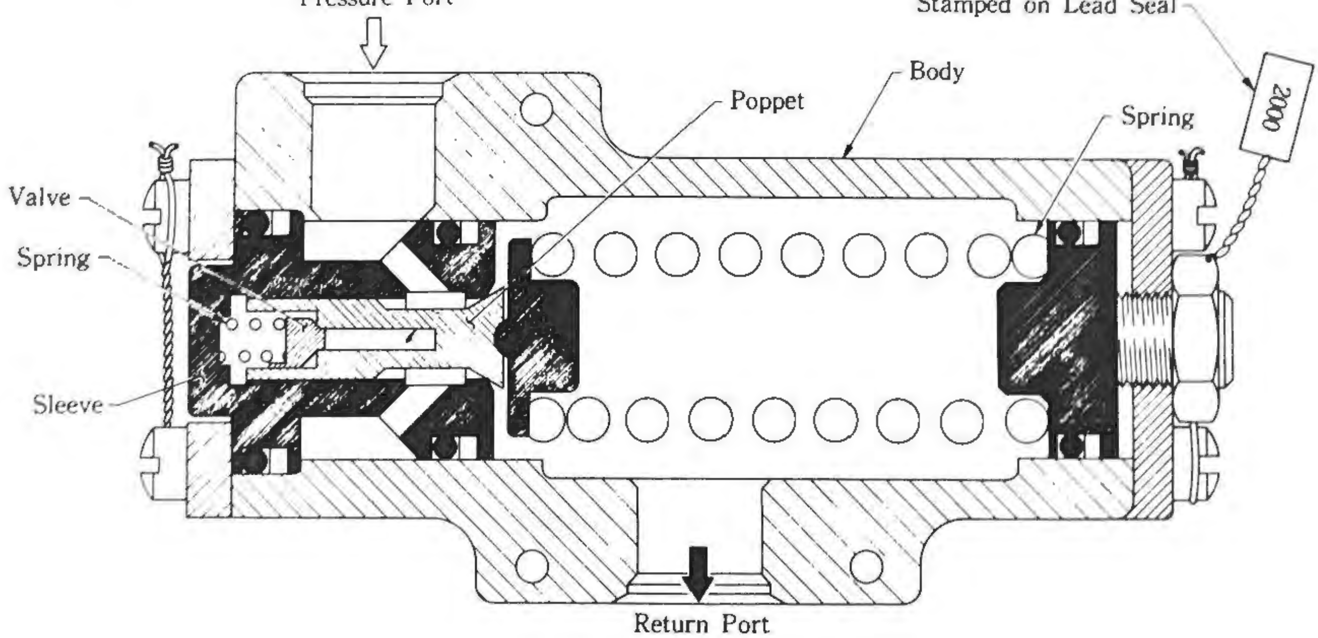
Wing Flap Hydraulic System

Figure 7-35

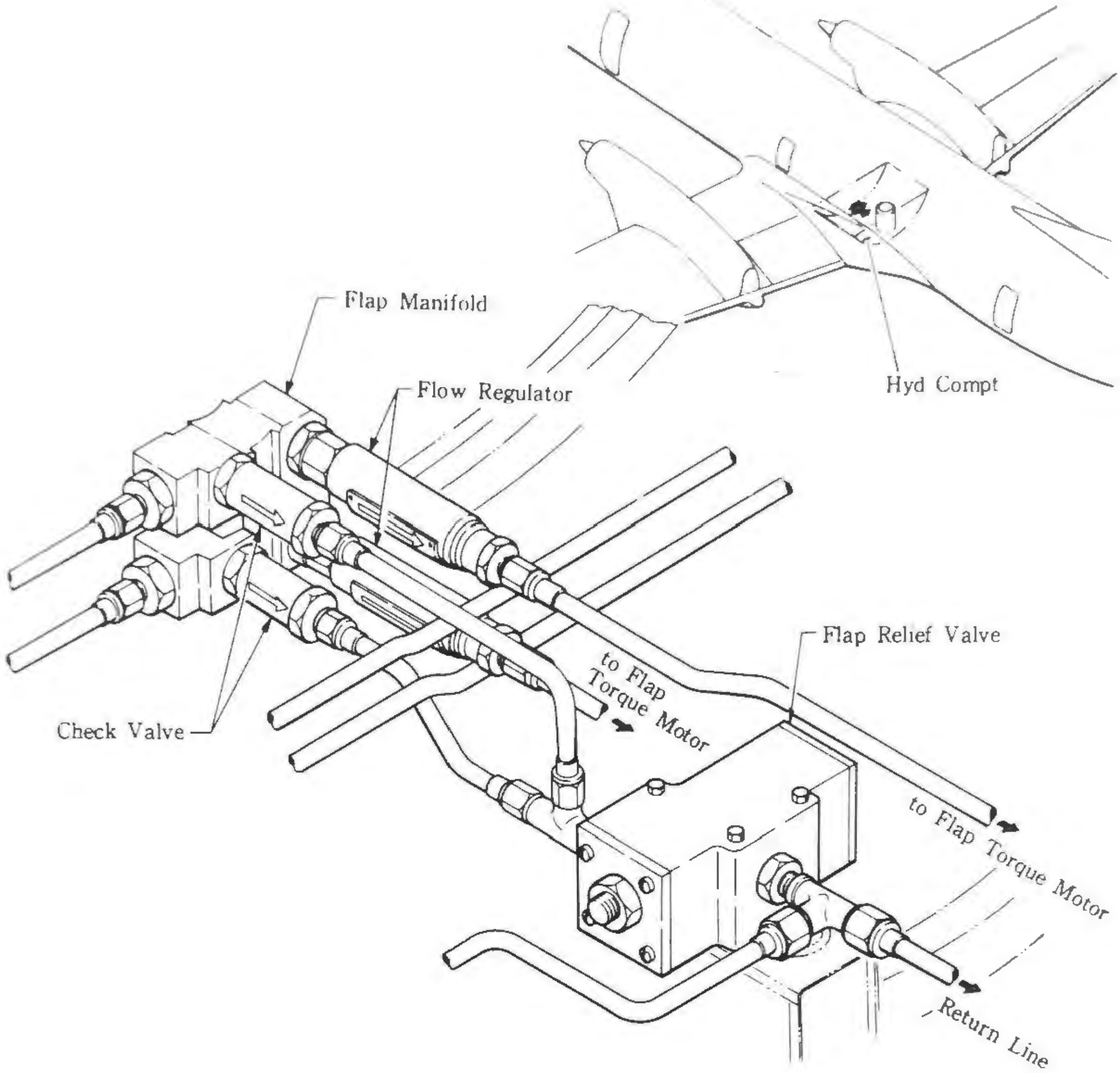


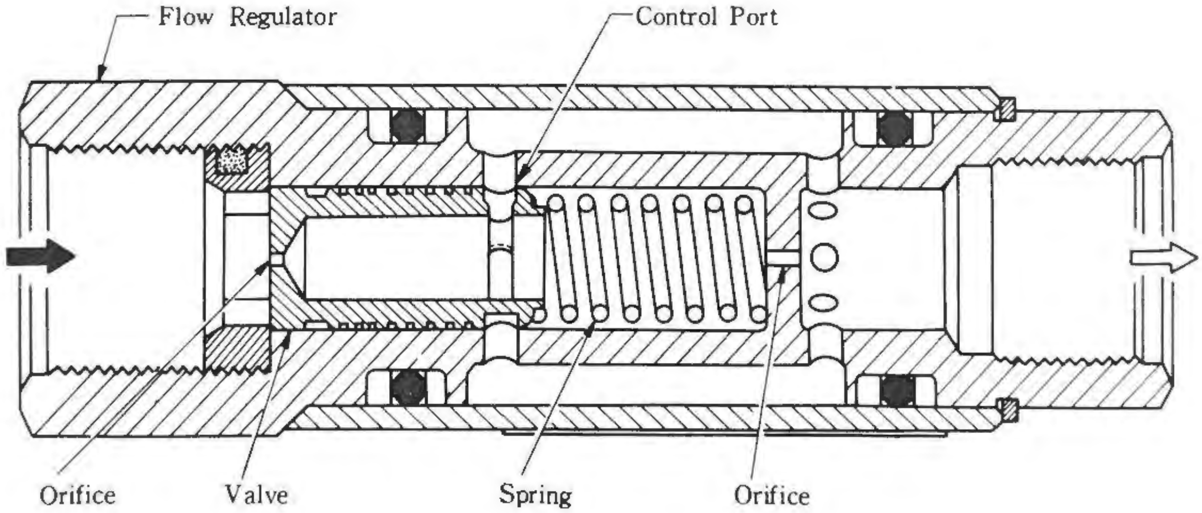
Flap Selector Valve
Figure 7–36





Flap Relief Valve
Figure 7–37





Flap Hydralic Flow Regulator
Figure 7–38

E. Flap Drive Hydraulic Motor

Performance (Vickers Inc.)

Type	Piston type
Max. press. range	3000 psi
Max. speed	4600 rpm
Torque produced	120 in.lb (at 3000 psi)

The hydraulic motor is a piston type motor installed on the flap drive center gear box, producing rotating force by pressure fluid from the flow regulator.

The first gear of the hydraulic motor drives the output shaft, i.e., torque tube at a speed reduced in two steps through a set of gears. The reduction ratio is 8.305.

Another set reduces the output shaft, torque tube in 3 steps, with the first gear attached on the torque tube, at a reduction ratio of 152.51.
The cam disc with reduced speed operates the down and up limit switches. The bevel gear with reduction ratio of 1:1 at the end of the cam drive shaft rotates the flap position transmitter. The output shafts, i.e., torque tubes of the gear boxes for both wings produce a torque of 7.425 Kg.m.

7.8.4 Flap Drive System (See Fig. 7-39)

The flap drive system is operated mechanically.

(1) Construction

A. On each flap are fixed three carriages which slide along the track (rail) installed on the wing structure.

B. On each flap are attached two drag links with hinges.
Each drag link is attached to the nut of the actuator screw jack with four bolts.

C. The actuators for the flaps are connected together with a torque tube. The torque tubes of the L.H. and R.H. flaps are connected together at both ends of the output shaft of the center gear box.

Numbering of Components of Drive Mechanism

Drive Mechanism	Number (Both Wings)	L.H. Wing	R.H. Wing
Torque tube	10	In fuselage No. 1 in numerical order . . . Most outboard No. 5	Same as the L.H. wing
Flap actuator (Screw jack)	8	Inboard No. 1 No. 2 Outboard No. 3 No. 4	Same as the L.H. wing
Drag link	8	Inboard No. 1 No. 2 Outboard No. 3 No. 4	Same as the L.H. wing
Track	10	Inboard No. 1 No. 2 No. 3 Outboard No. 4 No. 5 No. 6	Same as the L.H. wing
Carriage	10	Inboard No. 1 No. 2 No. 3 Outboard No. 4 No. 5 No. 6	Same as the L.H. wing

(2) Principal Components of Drive System

A. Hydraulic motor and flap drive center gear box.

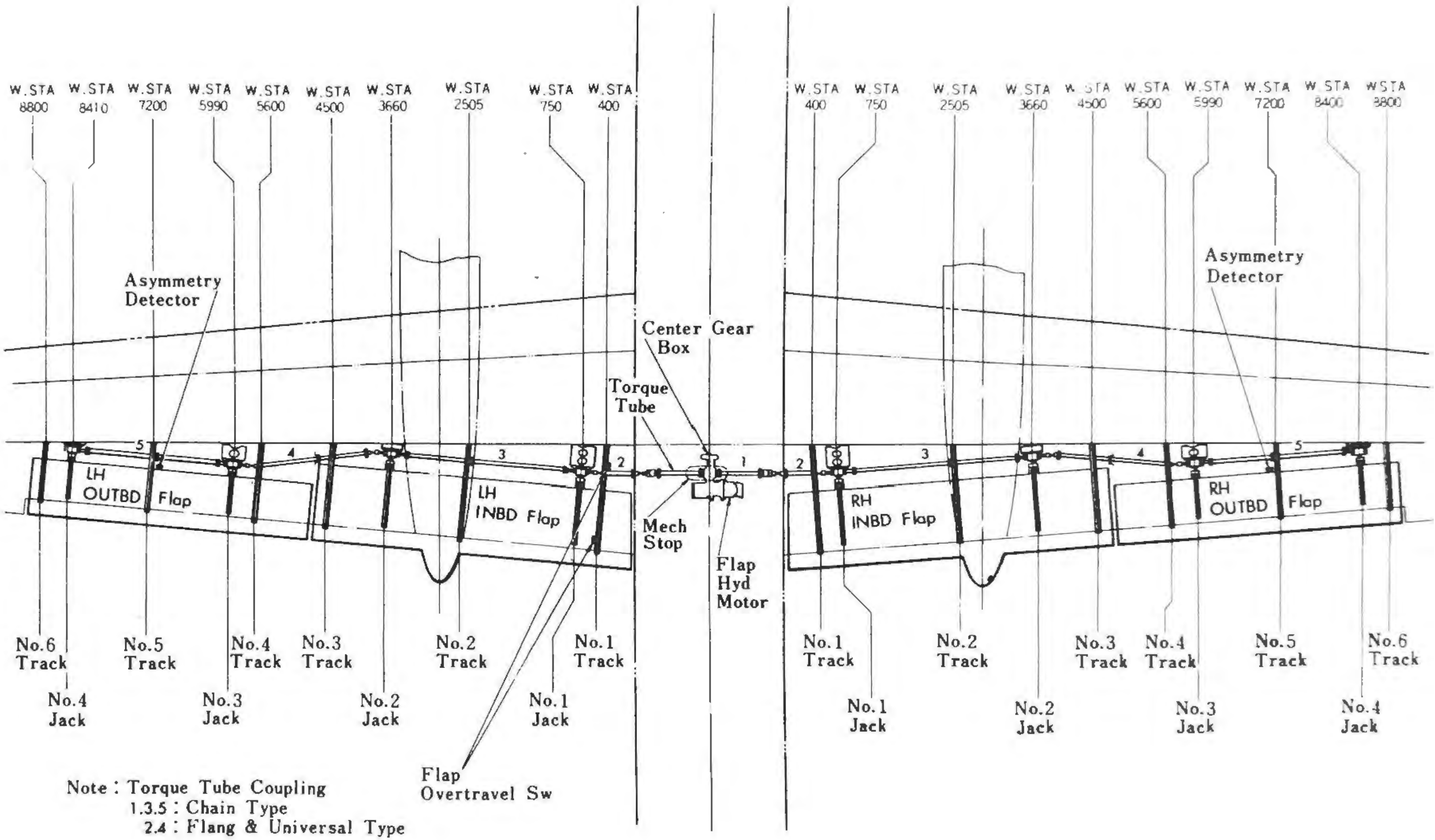
B. Flap mechanical stop

C. Torque tube

D. Flap actuator
Screw jack
Drag link

E. Carriage

F. Track (rail)



Wing Flap Drive System
Figure 7–39

(3) Operation of the Whole System

The torque of the flap hydraulic motor drives the torque tube through the gear box, driving the screw jack by the actuator to operate the flap.

A. Flap angle

$35^\circ \begin{smallmatrix} +0^\circ \\ -1^\circ \end{smallmatrix}$

B. Actuating time

Full stroke of the normal travel angle up 25 to 30 sec.
down 22 to 26 sec.

C. The amount of rotation of each component while the flap moves from 0° to 35°

Center gear box	input shaft (hyd. motor shaft)	805 revolutions
	Cam plate	227.5°
Torque tube		97 rev.
Actuator screw jack		35.5 rev.

D. Asymmetry protection

The asymmetry detectors located on the L.H. and R.H. outboard flaps stop the flaps when the difference of the L.H. and R.H. flap angles reaches 1° to 3.5°, lighting the warning lamp at the same time.

E. Flap Overtravel Switch

These switches are provided on the L.H. wing only, i.e., on the up side and the down side 1 ea., lighting the flap overtravel indicating lights on the R.H. part of the flap position indicator on the engine instrument panel when the flap overtravels the specified travel angle, stopping at the mechanical stop in case of failure of the up or down limit switch or flap overtravelling by emergency flap handle.

(4) Operation of Principal Components (See Figs. 7-40 and 7-41)

A. Hydraulic Motor and Flap drive Center Gear Box

The hydraulic motor of piston type produces 7.425 Kg.m of total torque at the output shaft through two sets of gears.
The gear train consists of

(a) Torque tube drive gear pinion and
(b) Cam and transmitter drive gear train.

(a) Torque tube drive gear train

The first gear driven by the hydraulic motor drives the output shaft to the torque tube at a speed reduced in two steps. The reduction ratio is 8.305.

(b) Cam and transmitter drive gear train

This consists of another set of gears installed on the output shaft of the (a) set.

The output shaft drives the cam disc and the flap position transmitter through the first gear installed on it at a speed reduced in 3 steps. The reduction ratio is 152.51.
The cam disc actuates the flap limit switch. The bevel gears, at the end of the cam disc shaft rotate the flap position transmitter at 1:1 speed.
From the front side of the gear box is protruding the output shaft which is connected to No. 1 torque tube at both ends.
On the output shaft protruding to the right is installed a sprocket which is connected to the mechanical stop mechanism through chains.

B. Flap Mechanical Stop

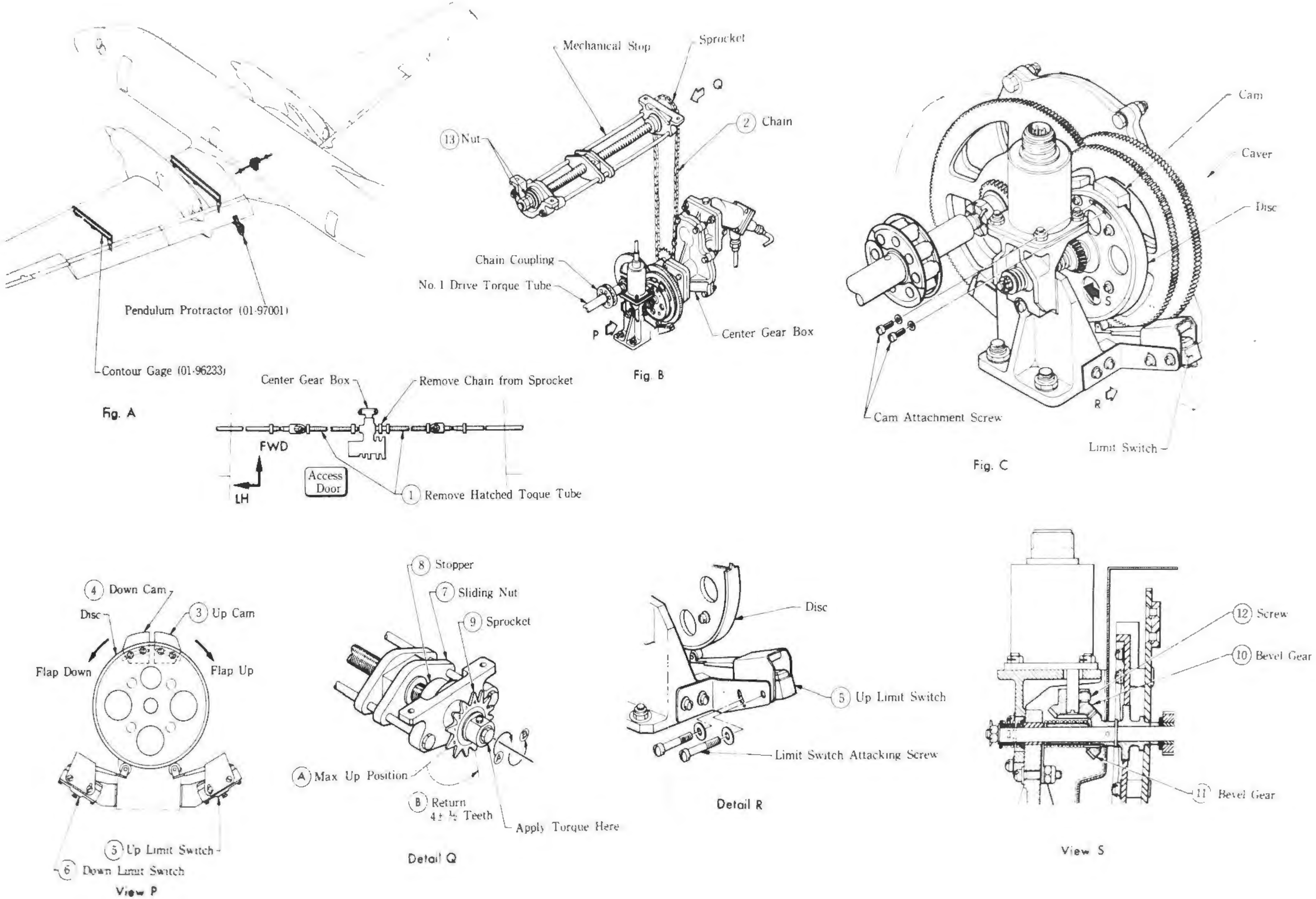
The mechanical stopper is installed on the ceiling of the hydraulic compartment. It stops the flap positively in case of failure of the flap limit switch or if the flap is travelled too much by means of the flap emergency handle.
If the stopper screw is rotated by the sprocket and chains, the sliding nut moves to the left or to the right, placing the sliding nut in contact with the stopper assembly.
Shock absorbing rubber is provided on the stopper assembly.

C. Torque Tube

The torque tubes are made of 1"ø stainless tube. 5 of them are provided on each wing, connected together with chain couplings or flange universal couplings. The chain couplings are used where the torque tubes are connected in a straight line, and the flange universal couplings are employed where directions are changed.

Torque tube		Coupling
No. 1	Both ends	Chain
No. 2	"	Universal
No. 3	"	Chain
No. 4	"	Universal
No. 5	"	Chain

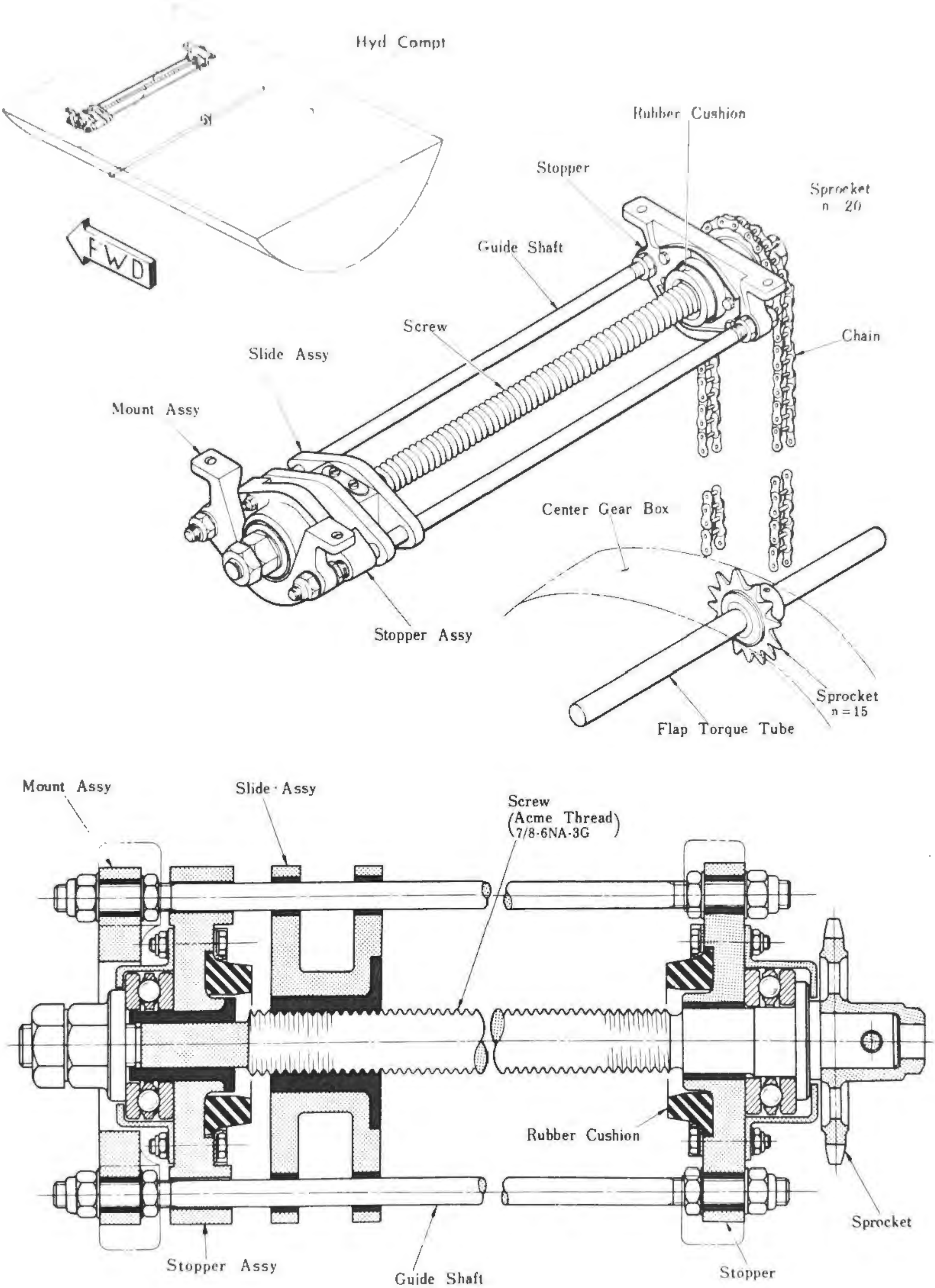
On the midway of the torque tube is provided a bakelite bracket to avoid its swinging motion. The screw jack is connected to the bevel gear box with a spline joint.



Wing Flap Center Gear Box Adjustment

Figure 7-40

Reserved



Flap Mechanical Stop
Figure 7–41

D. Flap Actuator (See Figs. 7-42 and 7-43)

The flap actuators are provided 2 ea. on the flaps. The L.H. and R.H. inboard flaps are interchangeable between them. So are the outboard flaps.
It consists of the bevel gear box and the screw jack. The rotation of the torque tube is reduced to 14/38 by the screw jack gear box, being transmitted to the screw jack. The outboard flap has 3 Acme nuts. The actuators are connected to the drag links installed 2 ea. on the flaps with 4 bolts at the actuating nut section, driving the flaps.

E. Carriage (See Fig. 7-44)

On each flap are fixed 3 carriages. The carriage with 5 sets (8 ea.) of rollers holds the ⊥ shape portion of the track from the top, bottom, left and right. The rollers are assigned symbols for identification. They are called A, B, C and D rollers from the front side of the carriage but no symbols are assigned to the two side rollers. However, they are called E tentatively in this training guide.

Name of Roller	Kind
A Roller	Ordinary roller
B "	Adjustable roller
C "	"
D "	"
E (side roller)	Rollers on No. 1, No. 3, No. 4 and No. 6 tracks are adjustable. Rollers on No. 2 and No. 5 rollers are ordinary ones.

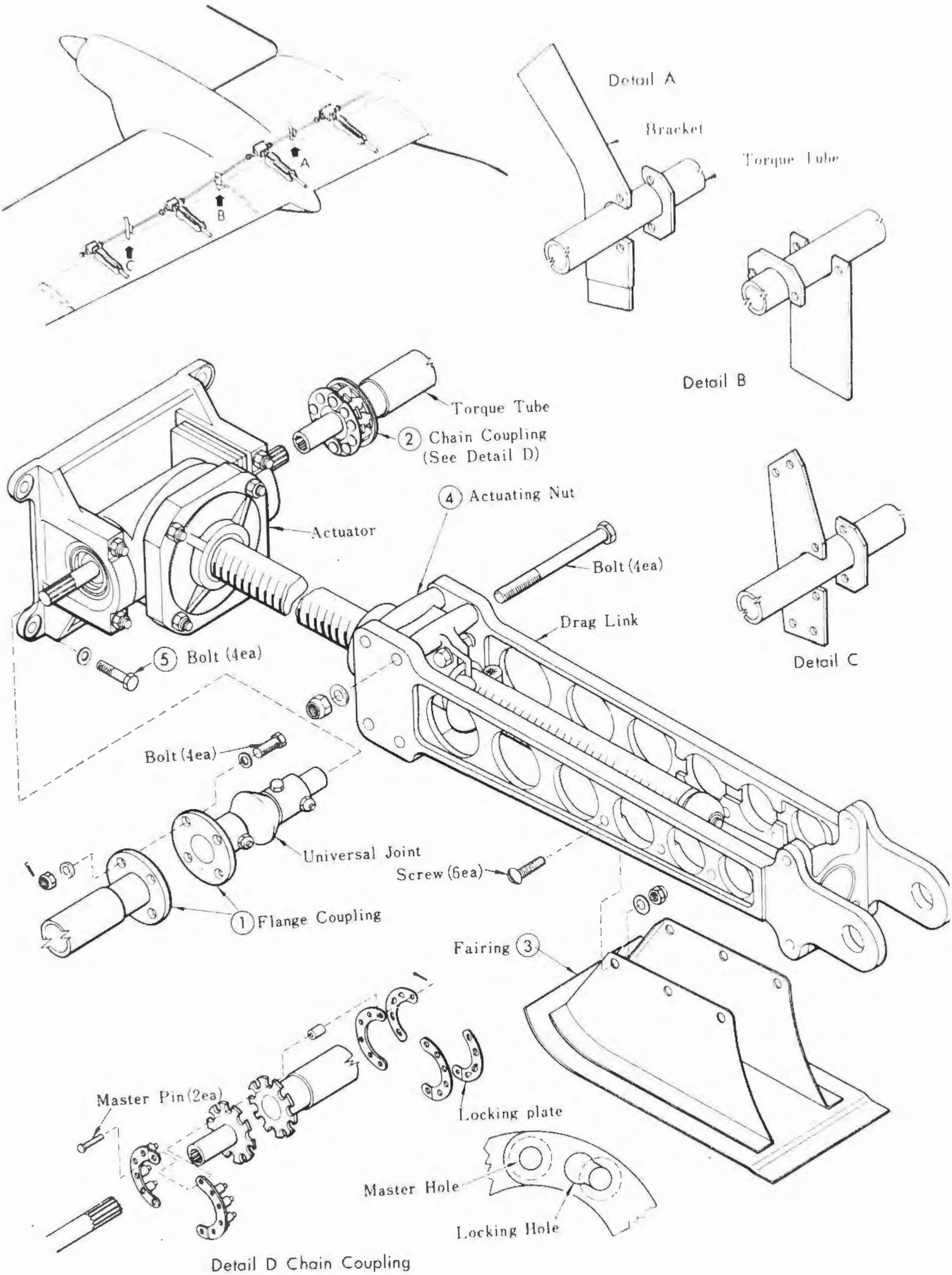
The attachment of the flap is adjusted by means of these carriage rollers.

F. Track (rail) (See Fig. 7-44)

The track constitutes a part of the wing leading edge structure. There are three tracks (rails) attached on the wing structure for sliding the flap. The track has two sections; I section and ⊥ section, made of Cr-Mo steel (4140) with hard chrome plating.
As the track is a perfect arc, the flap rotates from 0° to 35° around an imaginary center shaft. The three tracks on each falp has the same curvature.

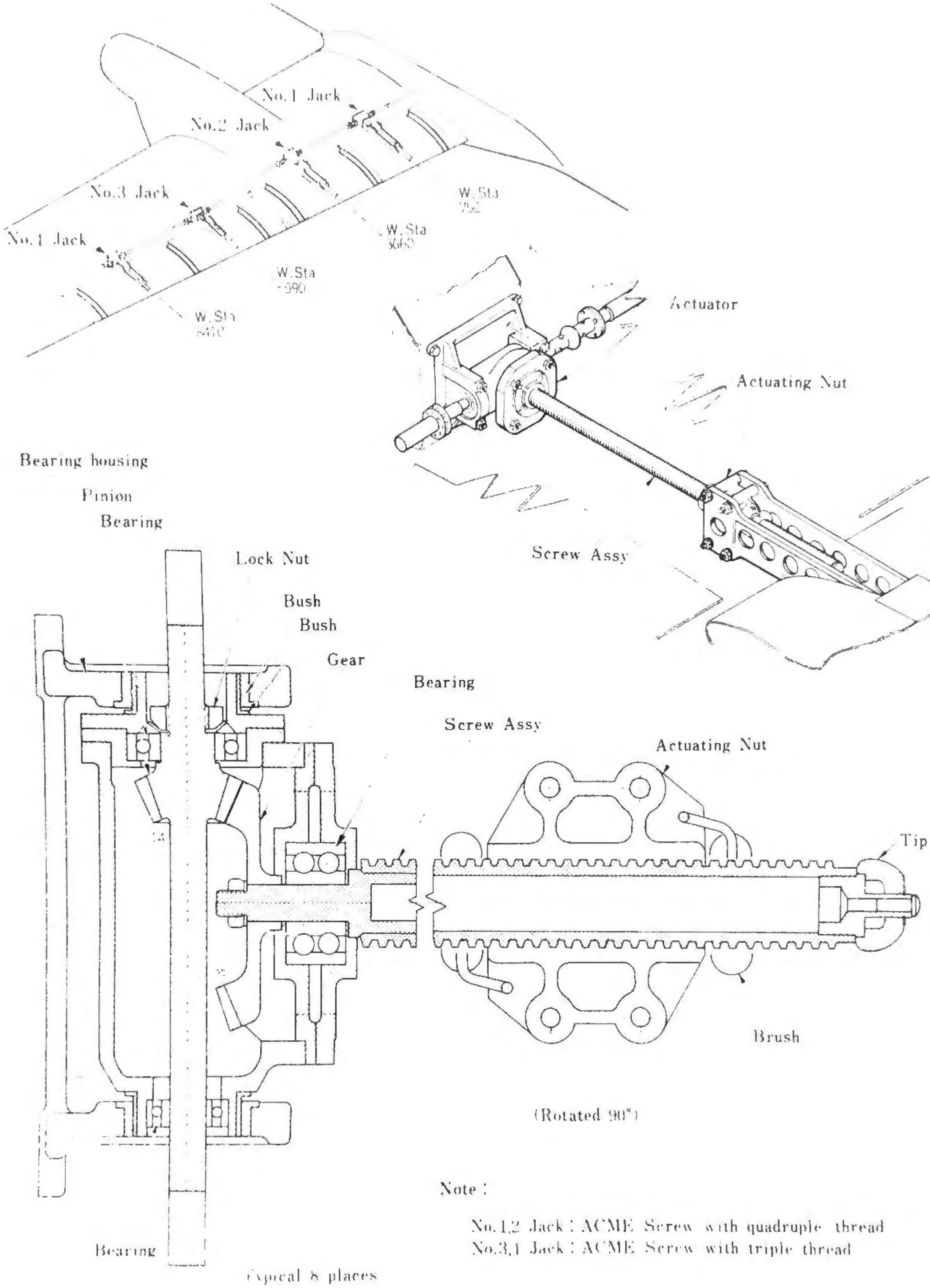
7.8.5 Flap Operation

The falp operation consists of the normal operation and the emergency operation systems. The normal operation is described below, while the emergency operation is dealt with in Chapter 6.



Flap Actuator Remove Installation

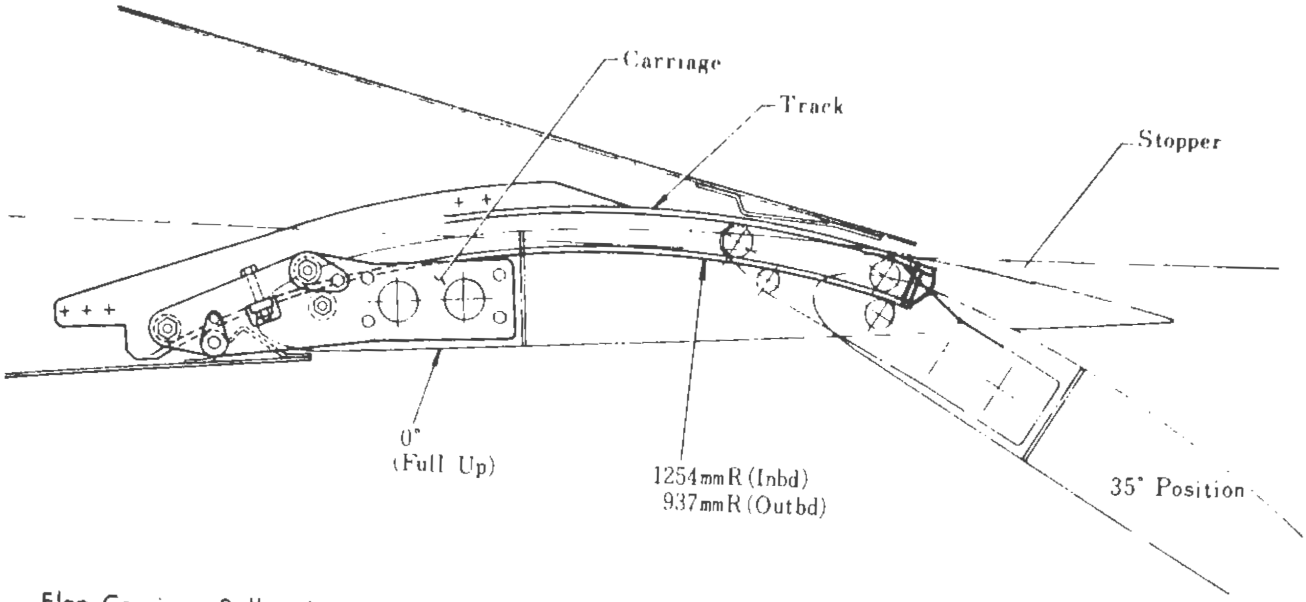
Figure 7-42



Note :

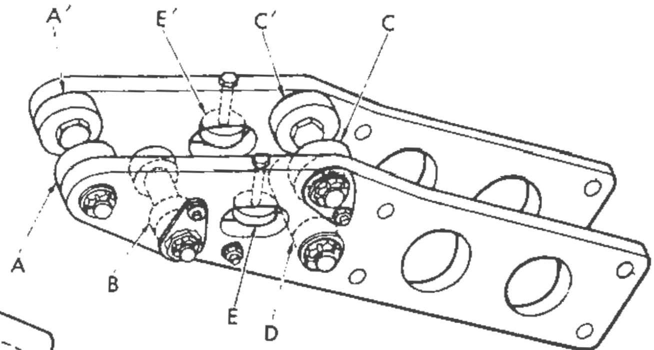
No.1,2 Jack : ACME Screw with quadruple thread
No.3,4 Jack : ACME Screw with triple thread

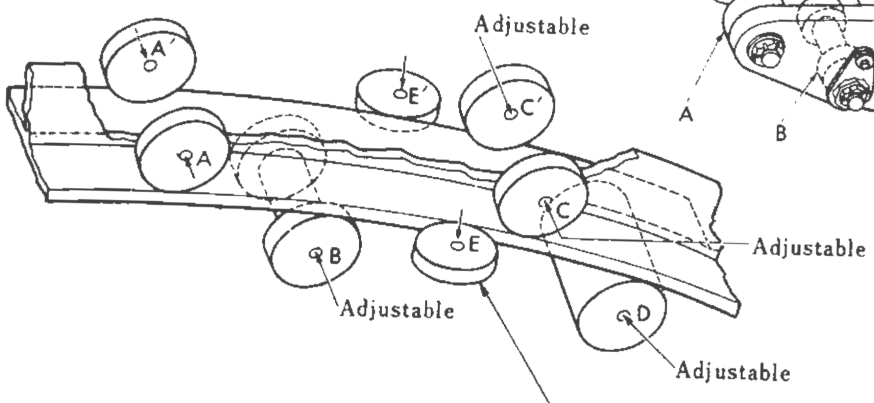
Flap Actuator
Figure 7-43

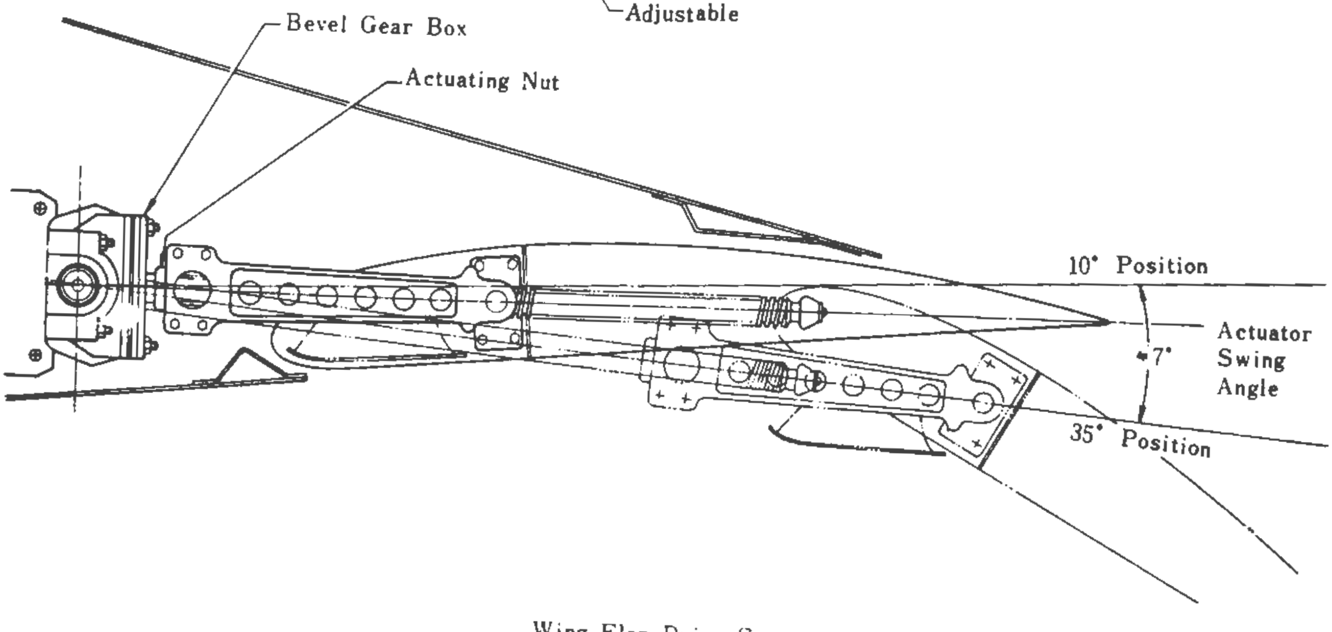


Flap Carriage Roller Arrangement

AA′ : Fwd Upper Rollers
B : Fwd Lower Roller (Excentric)
CC′ : Aft Upper Roller (〃)
D : Aft Lower Roller (〃)
EE′ : Side Roller







Wing Flap Drive System
Figure 7–44

If the flap control switch on the center pedestal is placed in "down" or "up", the solenoid selector valve in the hydraulic compartment is energized, supplying pressure oil to the hydraulic motor which begins to rotate. The rotating torque of the motor is transmitted to the torque tube through the gear box, rotating the screw jack to drive the flap.

On the flap is provided a sprocket which drives the slide nut of the mechanical stopper of the flap system.
In the gear box is located a cam disc which rotates together with the gear. If the flap completes its travel over the full stroke, the cam shuts off the limit switch, de-energizing the solenoid of the selector valve. Thus, the supply of pressure oil to the hydraulic motor is shut off, stopping the hydraulic motor and locking it hydraulically.

If the flap overtravels, the limit switch installed on the track of the flap is energized, lighting the indicator light on the instrument panel. Then, the flap control switch must be turned off.
If the flap control switch is turned off (neutral), the flap stops at any position.
The flap angle signals are transmitted to the instrument in the cockpit by the position transmitter installed on the gear box, indicating the flap angle on it.

7.8.6 Emergency Control System (See Figs. 7-45 and 7-46)

This system permits the manual control of the flap selector valve of the system in the hydraulic compartment in case of failure of the electrical system for the flap drive system.

On the R.H. panel for the copilot is provided the flap emergency handle which is connected to the cable through a crank. The cable, adjusted to a tension of 13 kg ± 1 kg, is connected to the lever actuating the selector valve.

If the emergency handle is moved "up" or "down", the selector valve completes a hydraulic passage mechanically, driving the flap. In this case, however, the limit switch does not work electrically, necessitating the manual control.

7.8.7 Procedures for Flap Control System Adjustment

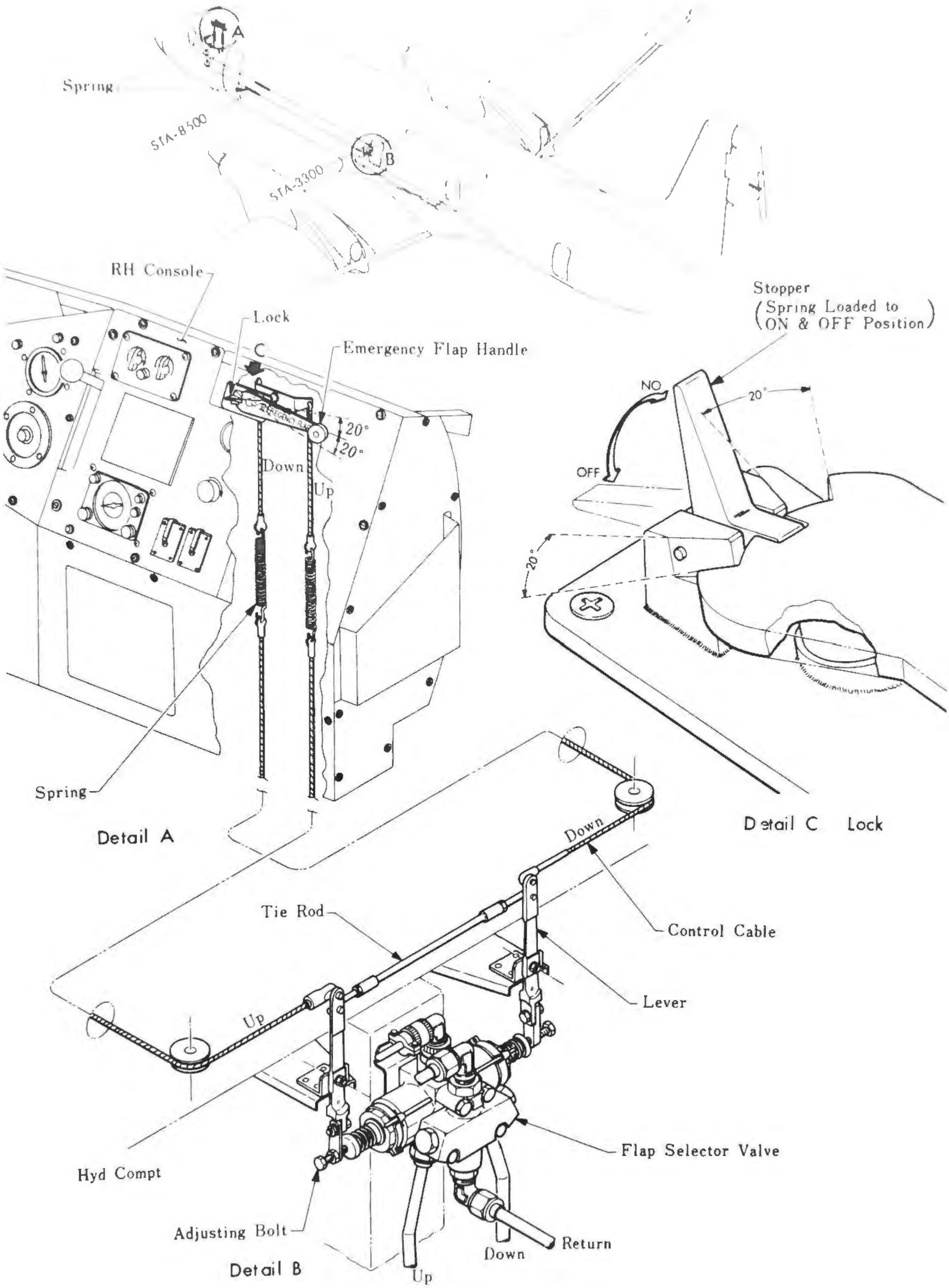
Use the counter gauge to measure flap 0° which is used as datum for various adjustments.

(1) Adjustment of Flap Attachment (Figs 7-32 and 7-44)

A. Attach the outboard and inboard flaps to the flap rails with carriage rollers A, B, C, D and E.

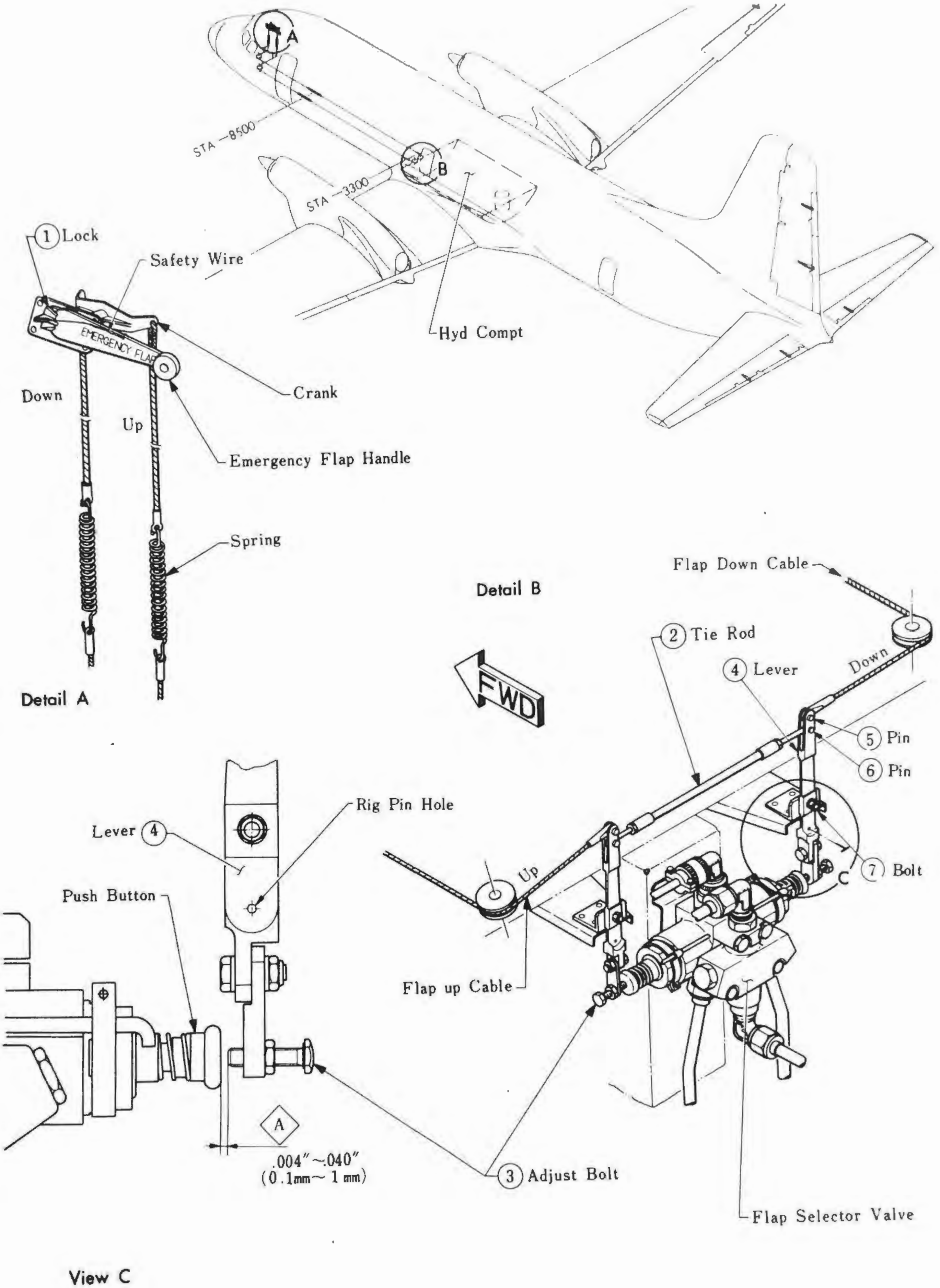
B. Check parallelism of each flap. Adjust it by rotating the torque tube.

C. Tighten the bolt of the actuating nut so that the misalignment of each screw jack and drag link bush is less than 1.5mm.



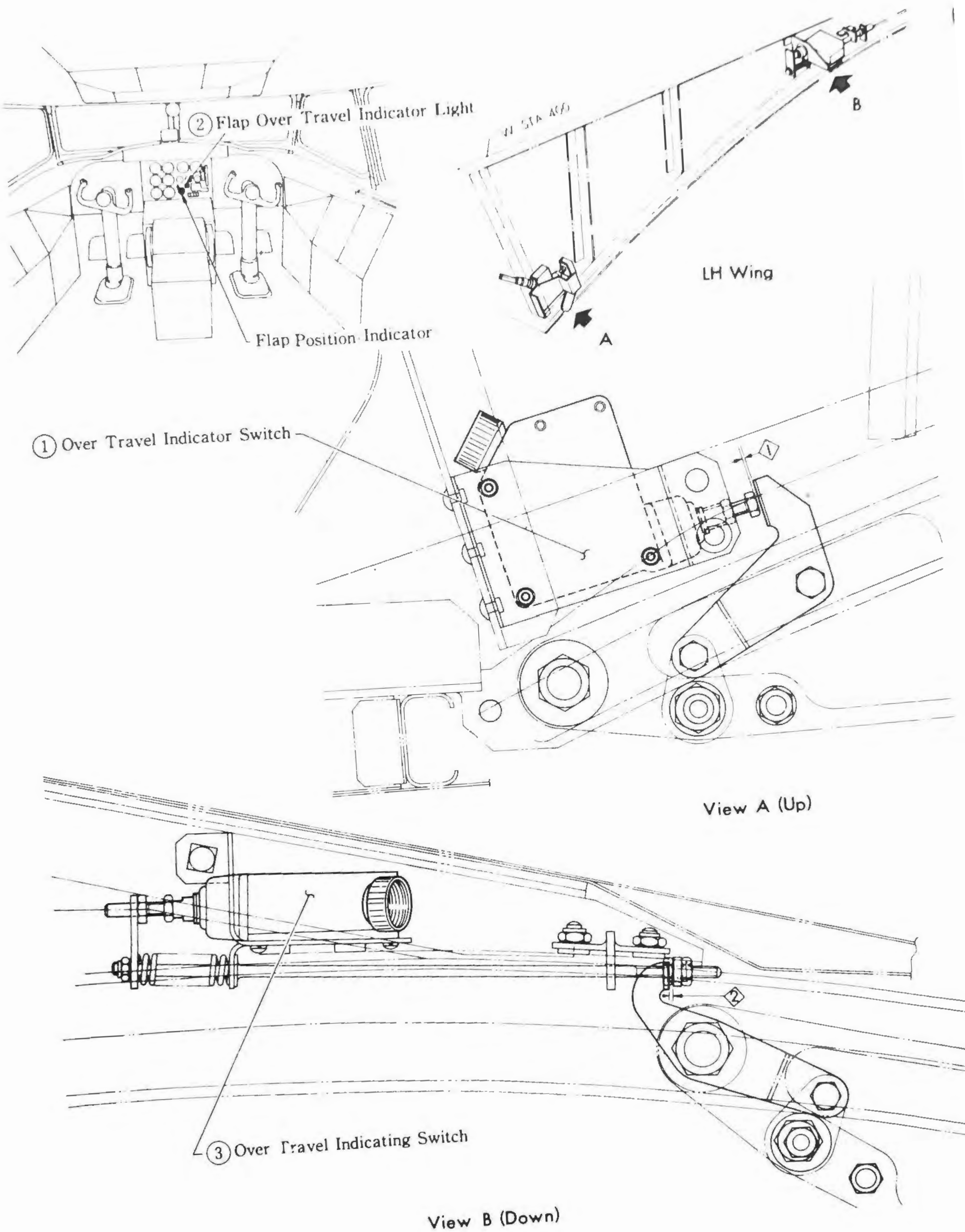
Wing Flap Emergency Control System

Figure 7–45



Wing Flap Emergency Control System Maintenance Practices

Figure 7–46



Flap Position Indicator
Figure 7-46A

D. Connect the torque tube between screw jacks.

E. Set the counter gauge. After adjusting B, C and D rollers for No. 1, No. 3, No. 4 and No. 6 rails so that the flap is flush with the wing contour, adjust rollers for No. 2 and No. 5 rails.

F. Lower the flap taking the inboard side stopper of No. 1 rail rear stoppers as datum until it comes in contact with "C" roller.

G. Connect the actuating torque tube between L.H. and R.H. flaps. The clearance between "C" roller and the stopper shall be less than 0.5mm.

H. Adjust the side rollers "E" for both inboard and outboard flaps.

Inboard side clearance for No. 2 and No. 5	+0.5 to 1.0mm
Outboard side clearance for No. 2 and No. 5	+0.5 to 1.0mm

(2) Adjustment of Flap Actuating Mechanism

A. Adjustment of Gear Box Limit Switch (Fig. 7-40)

(a) Set L.H. and R.H. inboard flaps to 0 on the counter gauge.

(b) Adjust the attachment of the cam and the limit switch so that the up limit switch of the gear box is turned off when the flap is up at 0° and the down limit switch is turned off when the flap is down at 34° to 35°.

B. Adjustment of Mechanical Stop Mechanism (Fig. 7-41)

(a) With the flap up and the mechanical stopper in contact, rotate the sprocket towards the down side by 4 ± 0.5 teeth.

(b) Actuate the mechanical stopper while the flap is down. Then, check the clearance between the flap roller and the rail stopper. If there is no clearance, adjust the nut of the mechanical stopper.

C. Adjustment of Over Travel Switch

(a) With the flap up at 0°, adjust the adjusting nut so that the clearance ◇1 is 1 to 2 mm.

(b) With the flap down and the mechanical stopper in contact, protrude the bolt by 2 to 3 mm and lock it.

(3) Tolerances

1.	Misalignment between the flap trailing edge and the wing contour	:	Chordwise	$^{+0}_{-3.0}$mm
		:	Vertical	±1.5mm
2.	Inboard flap and outboard flap	:		7.0 to 13.0mm
3.	Play of flap trailing edge (both inboard and outboard)	:		Max 4.0mm

7.8.8 Flap Asymmetry Protection System (See Figs. 7-47 and 7-48)

This system cuts off the electrical circuit to the flap selector valve, lighting the warning lamp at the same time, if asymmetry of 1° to 3.5° is detected between the flap angles of both wings.

This system is also provided with a test circuit. The asymmetry detectors are installed 1 ea, on the trailing edges of the L.H. and R.H. wings. The asymmetry is detected from the angles of the outboard flaps.

(1) Principal Components

A. Flap asymmetry detector
B. Flap asymmetry system return spring
C. Flap asymmetry relay
D. Flap asymmetry test switch

A. Flap Asymmetry Detector

The detector is installed inside the No. 5 track (center) of the outboard flap in the flap well, 1 ea. on the L.H. and R.H. flaps.

The main body consists of 3 cam plates and the corresponding limit switches located on the same shaft and the movement of the flap rotates the cam shaft through an actuating cable connected to the leading edge of the flap.

B. Flap Asymmetry Return Spring

This draws in the actuating cable when the flap is up.

C. Flap Asymmetry Relay

This consists of two sets of contacts. One set is used to shut off power supply to the flap selector valve, while the other is not in use.

D. Flap Asymmetry Test Switch

This permits electrical check of the asymmetry circuit. This should not be used to determine whether the system comes into action at 1° to 3.5° of the flap angle difference.

(2) Operation

The asymmetry system operates on the mechanical functions and the electrical functions.

The detector consists of 3 cam plates installed on the same shaft and the corresponding limit switches.

The cam lobes of the 3 cam plates are located 120° apart from each other. Consequently, if the cam shaft makes one rotation, each cam actuates the limit switch for 120°.

On the other hand, on the leading edge of the outboard flap is installed one end of a cable while the other end drives or is driven by a drum installed on the wing trailing edge. The cam shaft of the asymmetry detector, connected to the rotating shaft of the drum, detects the amount of rotation (flap angle) of the drum.

The detectors for the L.H. and R.H. flaps are connected electrically and cut off the electrical circuit to the selector valve and light the asymmetry indicating light (red) in the cockpit when the L.H. and R.H. flap angles become asymmetric (disturbing the limit switch actuating sequence of the cam lobes).

(3) Adjustment of Flap Asymmetry Detection Mechanism (Fig. 7-47)

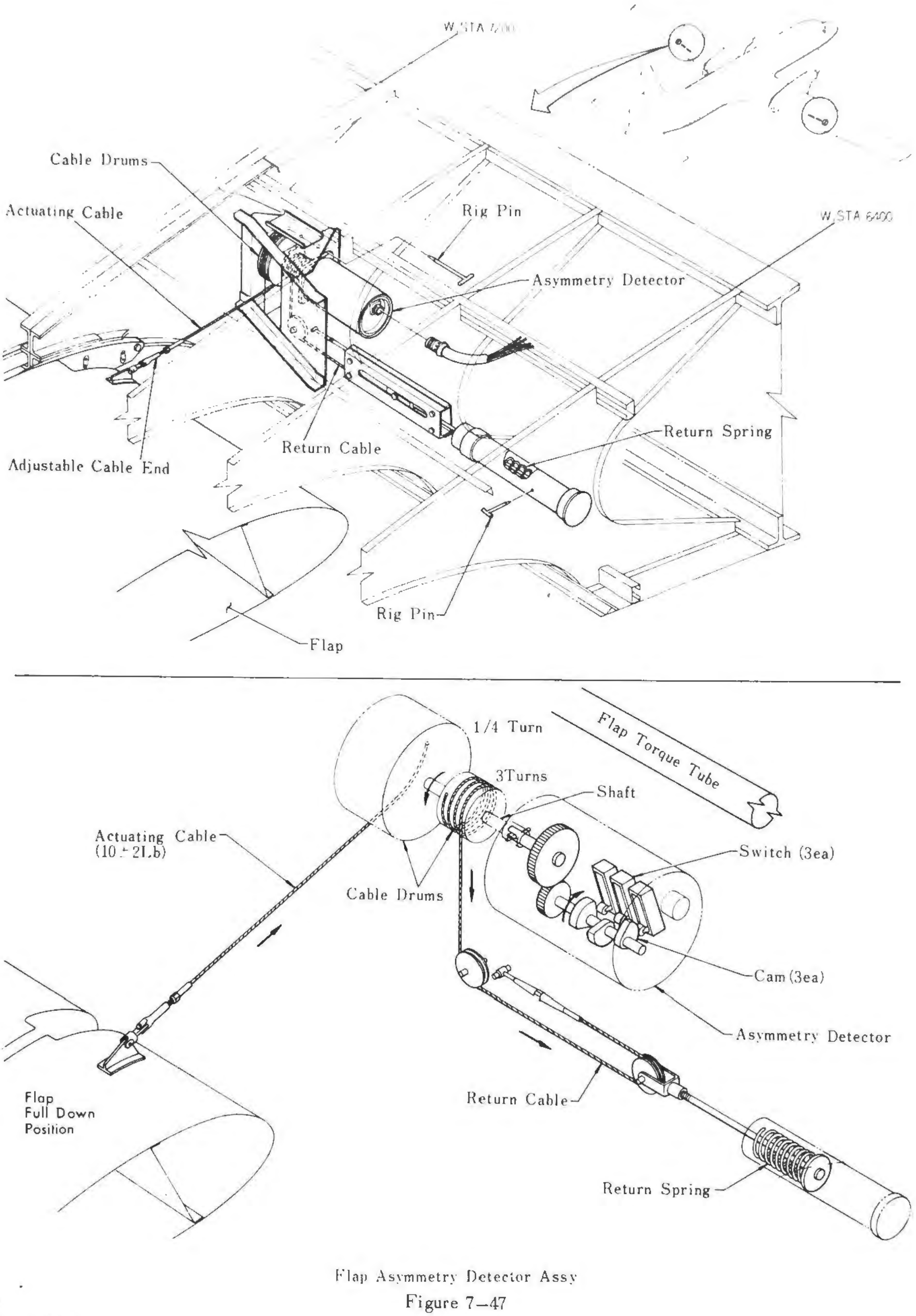
A. Fix the outboard flap so that the clearance between the rear stopper and the upper rear part of the carriage ("C" roller) is 21.5 mm (Flap angle 34°).

B. Fix the rig pin in the cable drum.

C. Compress the return spring to fix the rig pin.

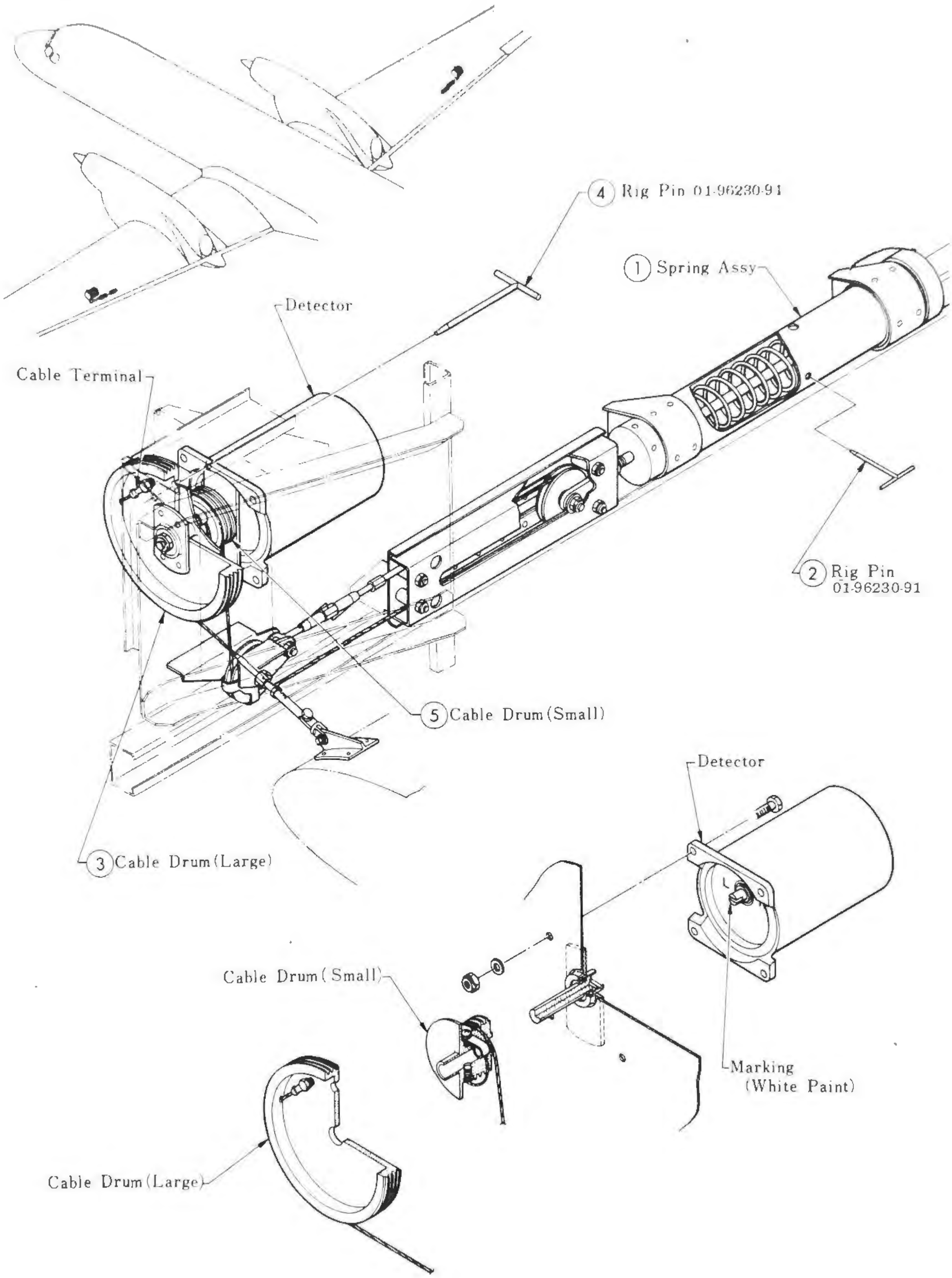
D. Adjust the terminal fitting so that the position of the pulley in the sliding groove for attachment is within the specified limits and then lock it.

E. Wind the cable around the drum (small) by 3 turns, wind it around the drum (large) by 1/4 turn, adjust the cable length by means of the turnbuckle and terminal, and lock it. Never tighten the cable until the spring washer can be seen from the spring washer position inspection hole.



Flap Asymmetry Detector Assy

Figure 7–47



Wing Flap Asymmetry Protection System Rigging

Figure 7–48

7.9 Gust Lock System

7.9.1 General (See Figs. 7-50 and 7-51)

If the gust lock lever on the right hand side of the pedestal in the cockpit is moved forward, pins enter the gust lock quadrants for the control surfaces, fixing them at their neutral positions, respectively.

The lock mechanism locks the aileron with a gust lock quadrant at the lower part of the torque tube in the flight control compartment, the rudder with a gust lock quadrant at the rudder torque tube and the elevator with a gust lock quadrant at the elevator torque tube.

The control surfaces can be locked even though they are not in their neutral positions. The lock pins are engaged and the control surfaces are locked if the control surfaces are moved towards their neutral positions while the lock levers are placed in the lock positions.

Between the gust lock lever and the low stop lever is provided an interlocking mechanism.

7.9.2 Control Lever and Locking Mechanism (See Fig. 7-51)

(1) Composition

A. Gust lock
B. Gust lock lever
C. Cable system

A. Gust Lock

The three control surfaces are provided with the same gust locks 1 ea. The gust lock consists of a gust lock assembly with a knock pin and a gust lock quadrant.

B. Gust Lock Lever

The gust lock lever is located on the R.H. side of the center pedestal in the cockpit and it has two positions, i.e., "ON" and "OFF". On the rotating shaft of the lever is provided the interlocking lever which does not permit the low stop lever to move to "FLIGHT" when the gust lock is "ON". On the other hand, the gust lock can not be engaged if the low stop lever is in "FLIGHT".

C. Cable System

Below the center pedestal is located a quadrant which is actuated by the gust lock lever through an idle and two rods. Two 3/32" cables, i.e., lock cable and unlock cable are connected to this quadrant. This cable is separated into two sets at a triangular link fitting, one set running to the aileron gust lock. The other one is separated again into two sets at the cable end, being connected to the elevator and the rudder gust locks, respectively. The unlock side cable has always less tension than the lock side.

(2) Lock Mechanism

A push-pull rod is attached to the gust lock lever, actuating a quadrant at its end (below the floor) to transmit the lever movement to the cable. This push-pull rod is installed with 8° overtravel in relation to the gust lock lever. As the rod with the interlocking lever moves ahead of the rotating shaft of the gust lock lever, the gust lock lever moves forward abruptly, accomplishing the over center locking.

Under the above conditions, the control surfaces are locked against the unlock spring, the over center lock of the locking mechanism in disengaged automatically if the lever is pushed hard rearward or the cable is cut, drawing back the lever by the unlock spring of the gust lock to be unlocked.

Even if the gust lock is in the lock position, there is play at the knock of each gust lock. Consequently no excessive force is applied to the mechanism of the control system. Under this condition, each knock pin enters the hole of the corresponding quadrant and is locked if the pedal, control column or aileron control wheel is placed in their neutral positions, respectively.

7.9.3 Procedures for Gust Lock System Adjustment (See Fig. 7-55)

(1) Neutral Fixed Points (4 locations)

Number	Fixed to	Location	Fixing method
1	Quadrant	Qaudrant	Rigging pin
2	Aileron gust lock	Gust lock Ass'y	"
3	Rudder gust lock	"	"
4	Elevator gust lock	"	"

(2) Adjusting Procedures

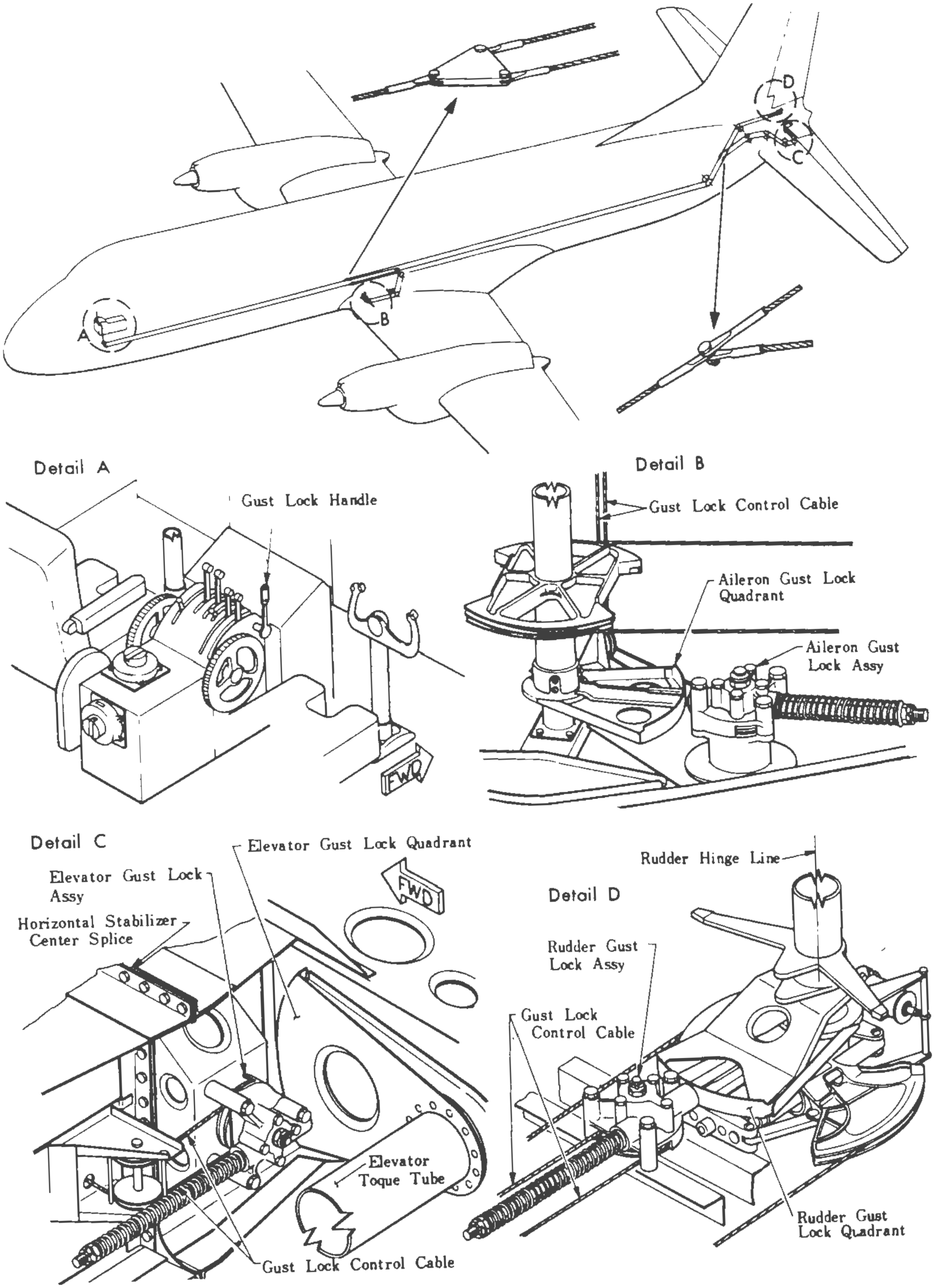
A. Place the gust lock levers in the "UNLOCK" positions.

B. Fix numbers 1, 2, 3, and 4.

C. Adjust the cable in accordance with the tension chart in Fig. 7-56.

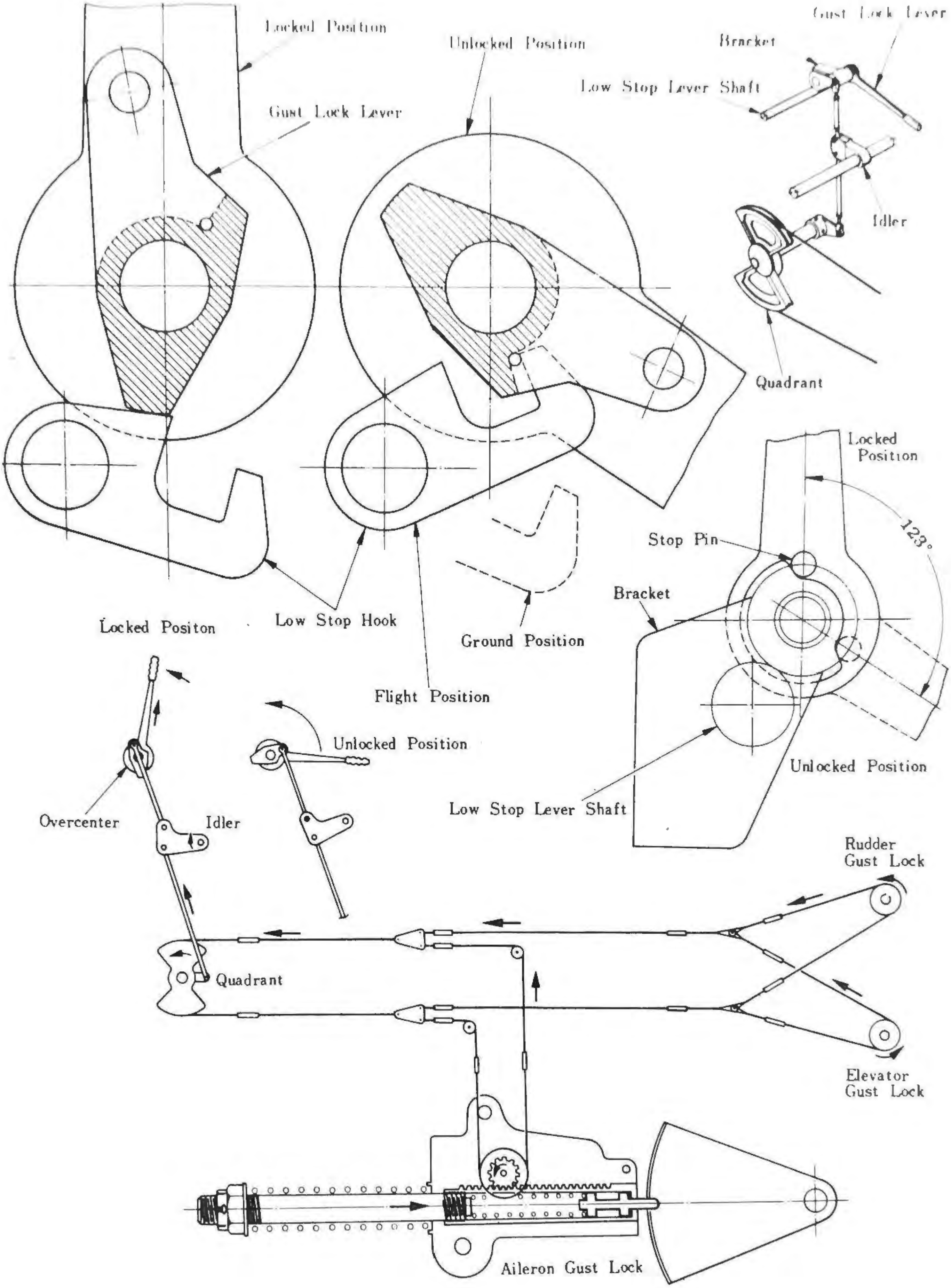
D. Dislocating the three control surfaces from their neutral positions, place the gust lock lever in the "LOCK" positions.

E. More each control surface and make sure that the knock pins enter the quadrant holes and the control surfaces are locked.



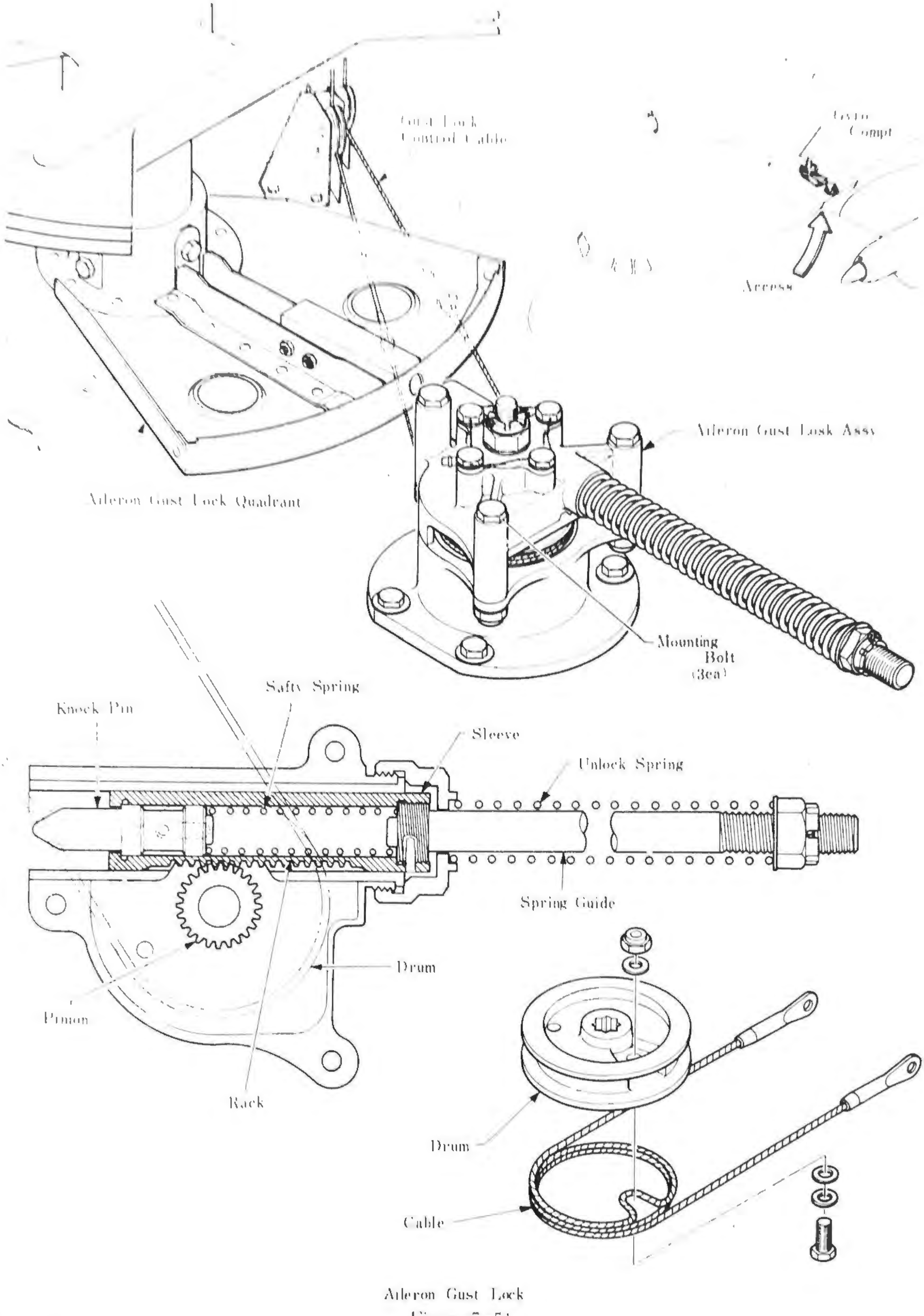
Gust Lock System

Figure 7–49



Gust Loc! System

Figure 7–50



Aileron Gust Lock
Figure 7-51

CHAPTER 20

LIST OF EFFECTIVE PAGES

Chapter Section Subject	Page (Code)	Date
20-L.E.P.	*1	Sep 30/86
	2	May 20/83
	*3	Sep 30/86
	*4	Sep 30/86
20-T.O.C.	i	May 20/83
	ii	BLANK
20-00-0	1	Aug 21/71
	2	Aug 21/71
20-10-1	1	May 20/83
	2	May 20/83
	3	May 20/83
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	5	May 20/83
	6	May 20/83
	7	May 20/83
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	12	May 20/83
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	16	May 20/83
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20-30-1	1	Nov 28/73
	2	Nov 28/73
	3	Nov 28/73

*The asterisk indicates pages revised or added by the current revision.

LIST OF EFFECTIVE PAGES

CHAPTER 20

Chapter Section Subject	Page (Code)	Date
20-30-1	4	Nov 28/73
	5	Nov 28/73
	6	Nov 28/73
	7	Nov 28/73
	8	Nov 28/73
	9	Nov 28/73
	10	Nov 28/73
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	2	Nov 28/73
	3	Feb 27/76
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20-41-10	1	Nov 28/73
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20-41-11	1	Nov 28/73
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*The asterisk indicates pages revised or added by the current resision.

CHAPTER 20

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Chapter Section Subject	Page (Code)	Date
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20-42-6	1	May 20/83
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LIST OF EFFECTIVE PAGES

CHAPTER 20

Chapter Section Subject	Page (Code)	Date	Chapter Section Subject	Page (Code)	Date
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	3	May 20/83		14	BLANK
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20-42-8	1	Dec 5/74		19	Nov 28/73
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				21	Nov 28/73
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	*4	Sep 30/86		2	Nov 28/73
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	8	Nov 28/73		4	Nov 28/73
	9	Nov 28/73			
	10	Nov 28/73	20-50-7	1	Nov 28/73
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	9	Nov 28/73		11	Nov 28/73
	10	Nov 28/73		12	Nov 28/73
	11	Nov 28/73			

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STANDARD PRACTICES

CADMIUM PLATING

1. Preface

A. This section deals with cadmium and cadmium-titanium alloy plating processes used in YS-11 and YS-11A. The plating processes described here are strictly intended as a guide, and therefore other appropriate methods, if available, may be followed.

B. The details of the cadmium plating conform to Federal Specification QQ-P-416 or MIL-S-8837 and the cadmium-titanium alloy plating conforms to AMS2419.

2. General

A. Plating Processes

(1) Cyanide process

(2) Borofluoride process

(3) Vacuum evaporation process

(4) Porous cadmium process

(5) Cadmium-titanium alloy plating process

B. Scope of Application

(1) The cyanide process is applied as a rule to steel parts having a tensile strength of less than 178 ksi (125 kg/mm^2).

(2) Heat-treated steel parts having a tensile strength of 178 to 219 ksi (126 to 154 kg/mm^2) should be treated by any of the borofluoride process, vacuum evaporation process, porous cadmium plating process, and cadmium-titanium plating process.

(3) Heat-treated steel parts having a tensile strength of more than 219 ksi (154 kg/mm^2) should be treated by any of the vacuum evaporation process, porous cadmium plating process, and cadmium-titanium alloy plating process.

NOTE: Any of the vacuum evaporation, porous cadmium plating and cadmium-titanium alloy plating processes may be adopted even when the borofluoride process is specified.

3. Repair

A. When isolated slight scratches and worn portions exist.

Keep using the part if its base metal is slightly exposed, or coat the part with corrosion preventive compound. (P-9, P-10).

B. When it is difficult to re-plate a part showing white corrosion products.

NOTE: Repair stated in this section is not applicable to a part whose surface area requiring repair exceeds 0.23 in^2. (1.5 cm^2) or 25% of the total surface area of the part.

(1) After wetting corrosion products with water or oil, remove them with #500 or finer emery paper.

(2) Phosphoric acid cleaner treatment (Refer to 20-10-4.) Apply one of the following solutions with a brush, cloth or a sprayer for one minute.

(a) MIL-C-38334 40 to 60% (by volume)

(b) Undiluted TEC 362 solution

(3) After washing in water and drying, coat the surface in accordance with the following procedure.

(a) One coat of wash primer (Refer to 20-41-2.)

(b) One coat of zinc chromate primer (Refer to 20-41-3.)

(c) Two coats of aluminized lacquer MIL-L-7178 (Refer to 20-41-5.)

C. When a symptom of corrosion is shown (all surfaces plating).

(1) Immerse the part in the following strippable solution at room temperature until the coating is stripped.

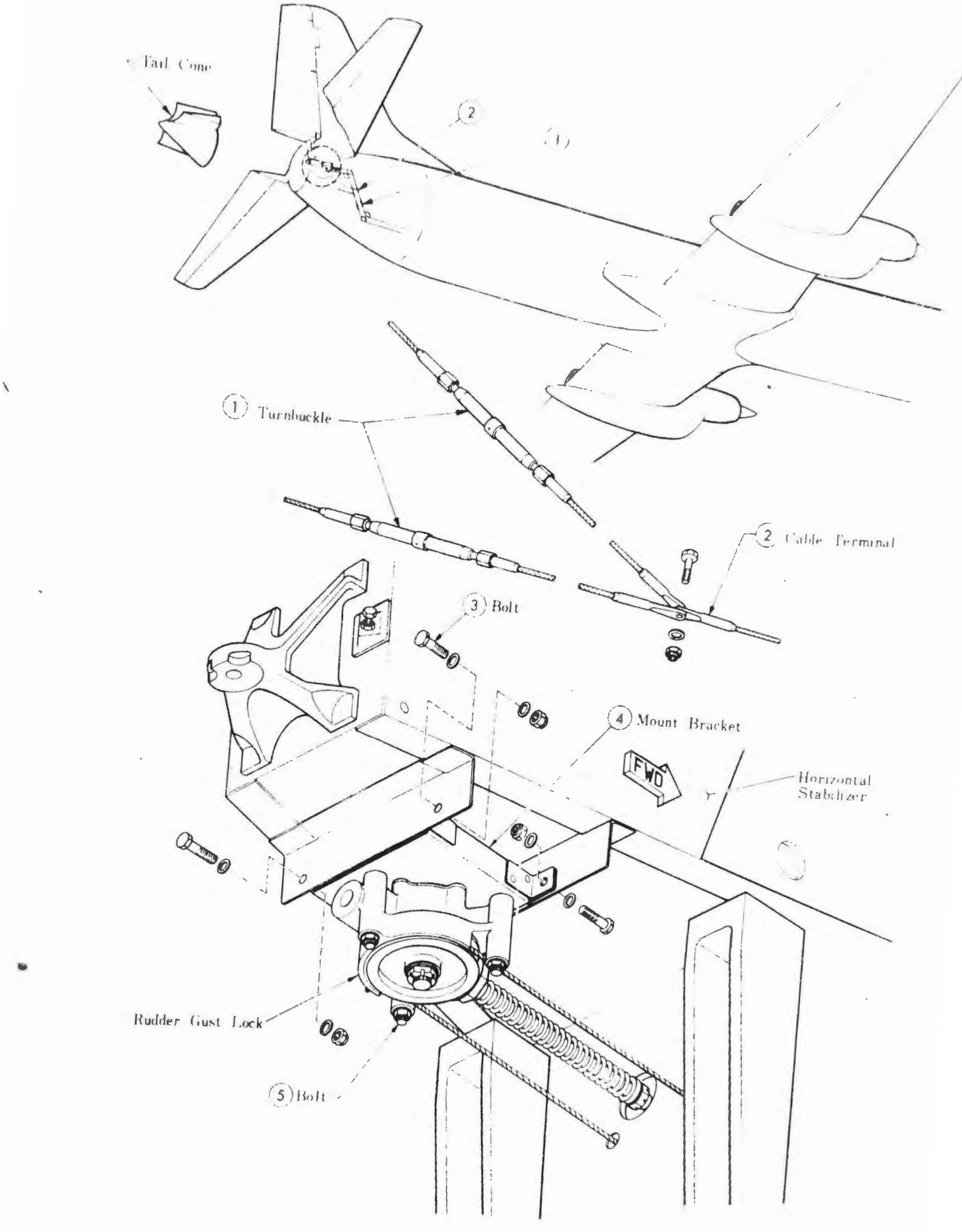
Ammonium nitrate : 10 to 15% (by weight)

(2) After washing in water, immerse the part in a hydrochloric acid solution at room temperature for five seconds max.

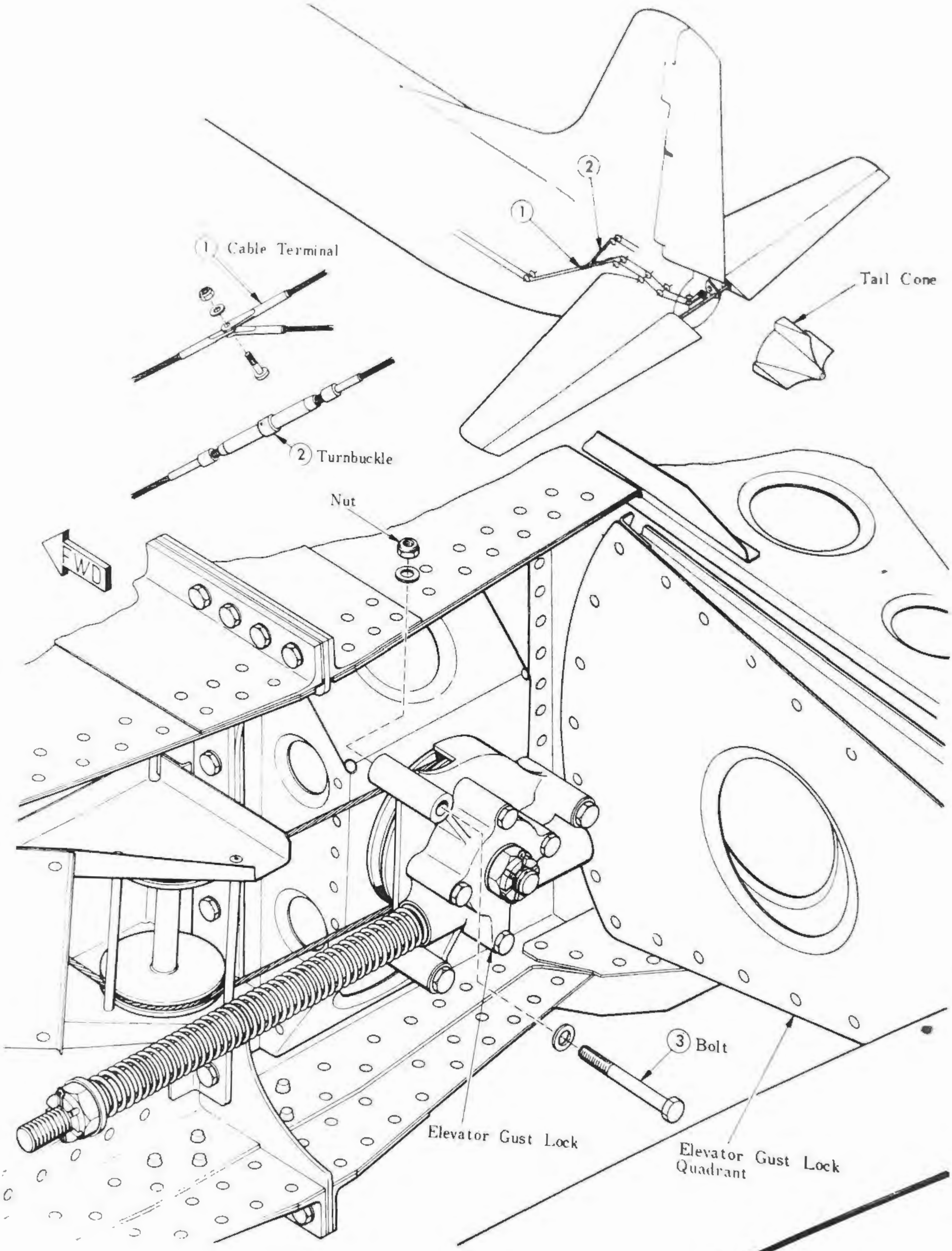
Hydrochloric acid (20° Baume) 2.6 to 4.3% (by volume)

(3) After washing in water, immerse the part in a cyanide neutralized solution at room temperature for 5 to 15 seconds.

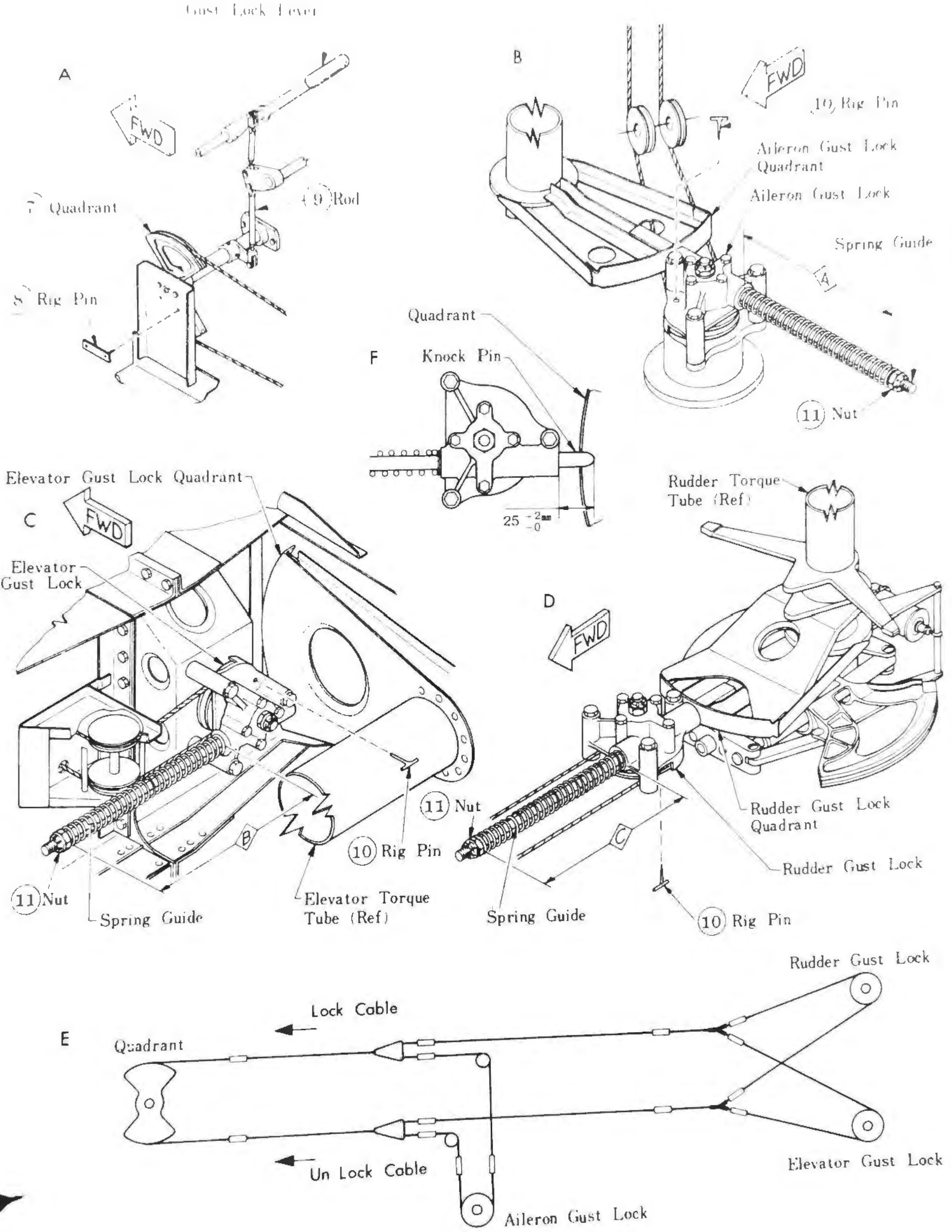
$\begin{cases} \text{Sodium cyanide : 30 to 60 g/}\ell \\ \text{Sodium hydroxide : 7.5 to 22.5 g/}\ell \end{cases}$



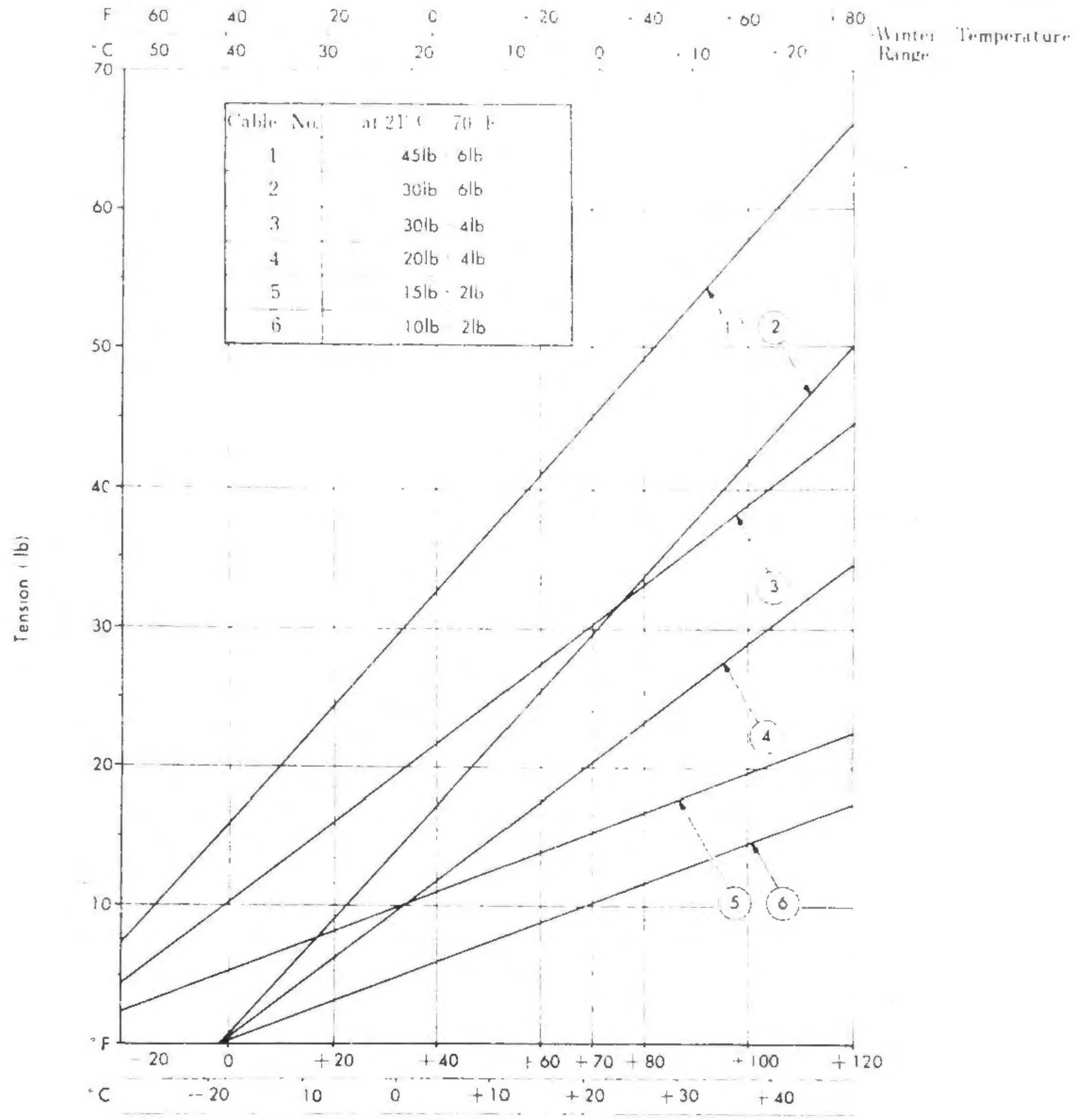
Rudder Gust Lock
Figure 7-52



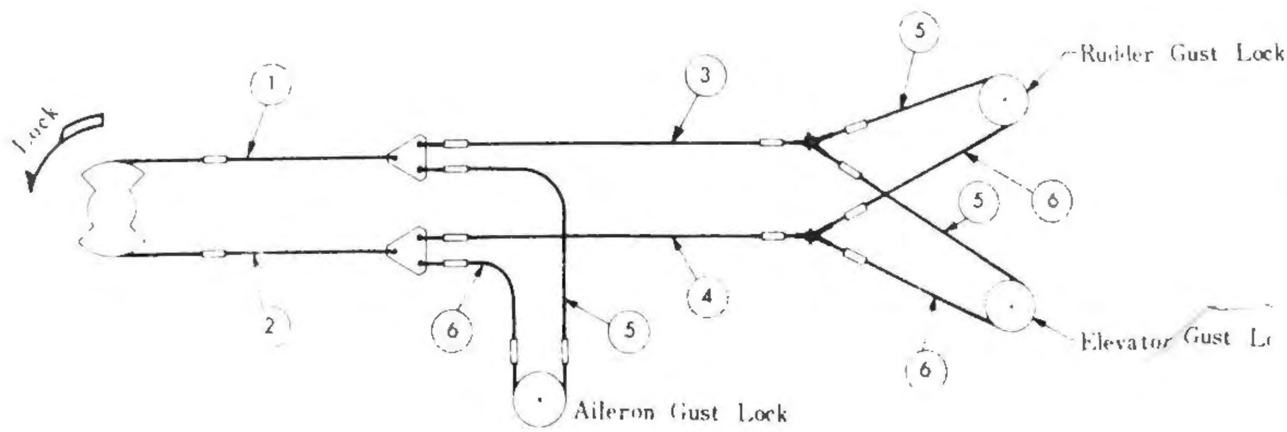
Elevator Gust Lock
Figure 7–53



Gust Lock System Rigging
Figure 7–54



Cable No.	at 21°C 70°F
1	45lb 6lb
2	30lb 6lb
3	30lb 4lb
4	20lb 4lb
5	15lb 2lb
6	10lb 2lb



Gust Lock Control Cable Tension Chart

Figure 7-55

(4) After rinsing in water in hot water and drying, perform baking. (Refer to 20-43-1.)

(5) Replate the surface of the part after selecting an applicable plating method according to 2.B. Scope of Application.

D. When replating a part partially (when C. is not applied).

Note: Application of brush plating is limited only for steel materials less than 300 ksi (210 kg/mm^2).

(1) Polish the surface to be plated with 3M Scotch Brite (very fine) or #500 or finer emery paper using water.

(2) Apply brush plating or an equivalent process under wet condition. (Refer to 20-42-9)

Note: When applying to parts having strength more than 240 ksi (168 kg/mm^2), perform baking for relieving the hydrogen embrittlement after plating. (Refer to 20-43-1)

4. Pretreatment

A. Cyanide Process

(1) The part may be dipped in sodium cyanide solution 30 to 60 g/ℓ at room temperature for less than 30 min or in the following fluid composition at room temperature for less than 4 hours.

Sodium cyanide : 45 to 90 g/ℓ
Sodium hydroxide : 7.5 to 22.5 g/ℓ

(2) Immerse in any of the following solutions at room temperature for less than 10 seconds.

(a) Hydrochloric acid : 150 to 300 cc/ℓ

(b) Hydrochloric acid : 500 to 550 cc/ℓ

B. Cyanide Process - Corrosion resistant Steel

First treat the part by cathodic etching in either of the following solutions at room temperature and then proceed to anodic etching. Current density is 5 to 14 A/ft^2 (0.5 to 1.5 A/dm^2)

(1) Sulfuric acid : 20 to 30% (by weight)

(2) Sulfuric acid : 15 to 25% (by volume)
Phosphoric acid : 75 to 85% (by volume)

C. Borofluoride Process

The part to be treated should be given any of the following pretreatments.

(1) Anodic etching in a sulfuric solution [sulfuric acid 23 to 27% (by weight)]

Treating conditions:

Temperature:	room temperature
Voltage:	3 to 7V
Time:	1 min. max.

(2) Immersion in either of the following solutions at room temperature for less than 10 sec.

(a) Hydrochloric acid : 150 to 300 cc/ℓ

(b) Hydrochloric acid : 500 to 550 cc/ℓ

D. Vacuum Evaporation Process

(1) The part may be immersed in a sodium cyanide solution at room temperature for not more than 30 min.

Sodium cyanide : 30 to 60 g/ℓ

(2) After rinsing in water and hot water, dry the treated part by application of clean air.

E. Porous Cadmium Process

Treat the part by either of the following processes:

(1) Sodium Cyanide Process

(a) Place the part in a rack by putting on clean cotton gloves so that you will never directly touch the part with hands.

(b) Dip the part into cold water and remove aluminum oxide with a brush.

(c) Immerse the part in a sodium cyanide solution.

Sodium cyanide : 35 to 45 g/ℓ

<u>CAUTION</u>: DO NOT WASH IN WATER.

STANDARD PRACTICES

CADMIUM BRUSH PLATING

1. Preface

A. This section deals with cadmium brush plating to repair cadmium plated parts less than 300 ksi (210 kg/mm^2) used in YS-11 and YS-11A, and also deals with cadmium brush plating for parts and portions for which immersion process is not applicable.

B. Brush plating is applied for repair of single parts, or for a part which is already installed on an airplane and is difficult to remove from the airplane, and whose position is preventable from remaining treatment solution.

C. Cadmium plating performed in accordance with this manual satisfies the main requirements of Federal Specification QQ-P-416.

2. Plating Equipment and Procedures

A. Devices and equipments in outline for brush painting are shown in Figure 1.

(1) Power Supplies
Power supplies shall provide adjustable D.C. voltage, an output polarity reversing switch, a precise volt-ammeter, and an integrating ammeter. Calibration is required.

Typical devices are shown in the followings.

(a) DALIC PLATING PROCESS

(b) SELECTRON CO., SELECTRON TYPE 6035.

(c) RAPID ELECTROPLATING PROCESS CO., RAPID PORTABLE PLATER.

(2) Plating Tools

It is desired to use a tool for plating (stylus) on the mardet (see Figure 1, 2) or a tool (stylus) consisting of an insoluble anode (carbon electrode), insulated handle, and cooling fins to help dissipate heat in the electrode. Also, methods for making anode (carbon electrode) pads which are attached to the stylus are shown in Figure 2. Cotton, Dacron or graphite felt, Scotch-brite, and Super Taffetta are used for pad materials, and the contact sections are fully piled up and are fixed with rubber bands, polyester string ring or tapes. Or they may be sewn together as shown in Figure 2.
Accommodate the anode to the size and shape of the applied surface, and process it to meet the applied surface as required.

B. Each Kind of Treatment Solution

(1) Degreasing solution : trichloroethylene or 1.1.1. tricloroethane (see paragraph 20-10-1)
Selectron Alkali Cleaner #SCN-410 (for alkali cleaner)

(2) Etching solution : Selectron Activator #2
Selectron Activator #3 (for high carbon steel)

(3) Cadmium plating solution : Selectron SPS 5070

(4) Nickel plating solution : Selectron SPS 563 (for corrosion resistant and heat resistant steel)

(5) Chromic acid treatment solution : Chromic anhydride (for type I)

(6) Chromate treatment solution : Iridite #3A (for type II)
Iridite #3B (for type II)

C. General Treatment

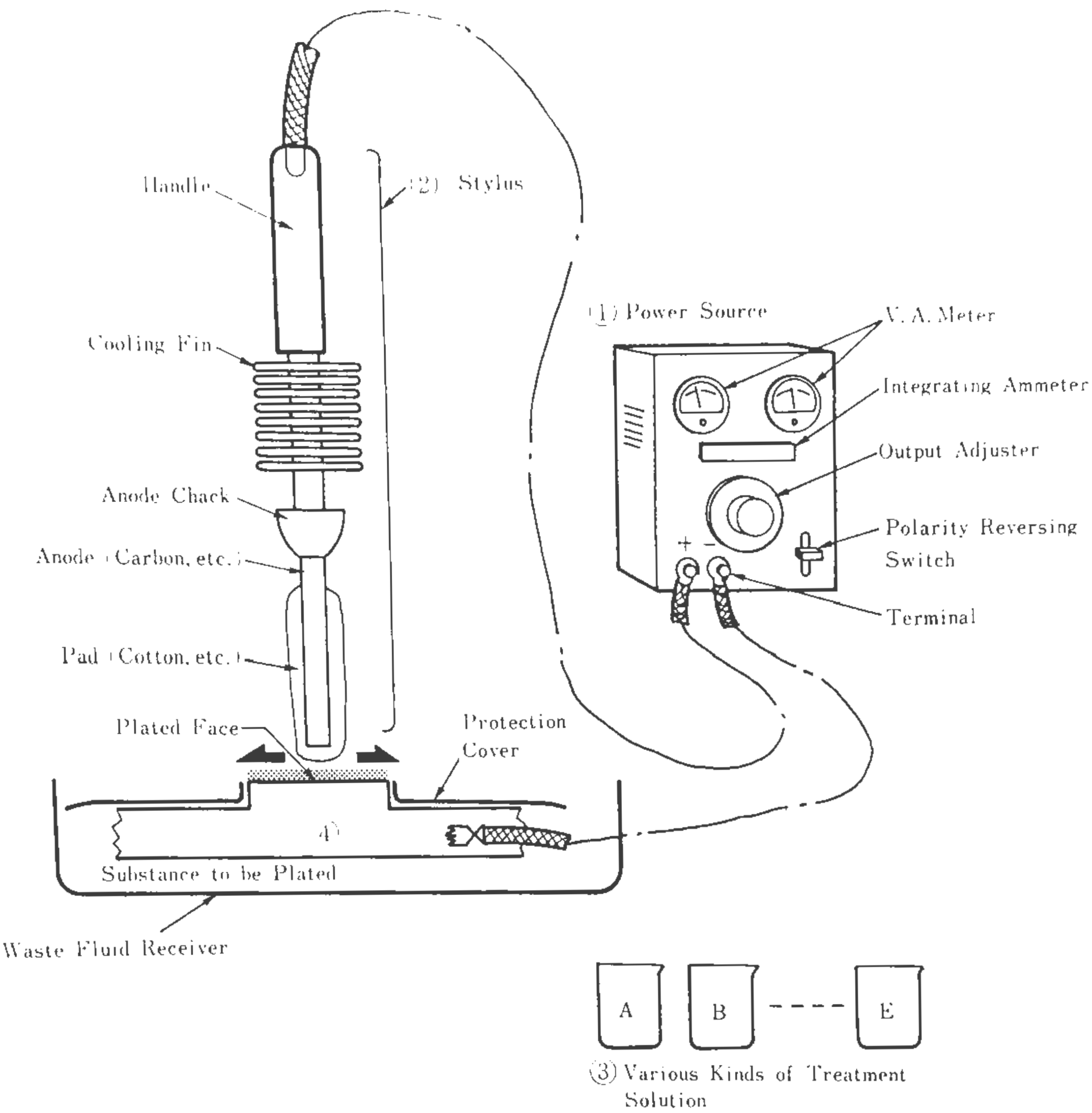
(1) The stylus shall be exclusively used for each treatment solution, and shall not be confused.
Since three kinds of solution are used for this plating, three styluses shall be prepared. But for high carbon steel and for corrosion resistant and heat resistant steel, each one more stylus shall be prepared so as to perform sequential works smoothly from degreasing to plating.

(2) Use a circular motion or a letter 8 decribing motion of the stylus with consistent movement (15 to 25 cm/sec) and with an extent of about 10% overlapping to ensure even distribution of the coating. (See Figure 3)

(3) Use each treatment solution by taking out a small quantity as necessary, and throw it away each time after completion of work. Do not return it to the original container.

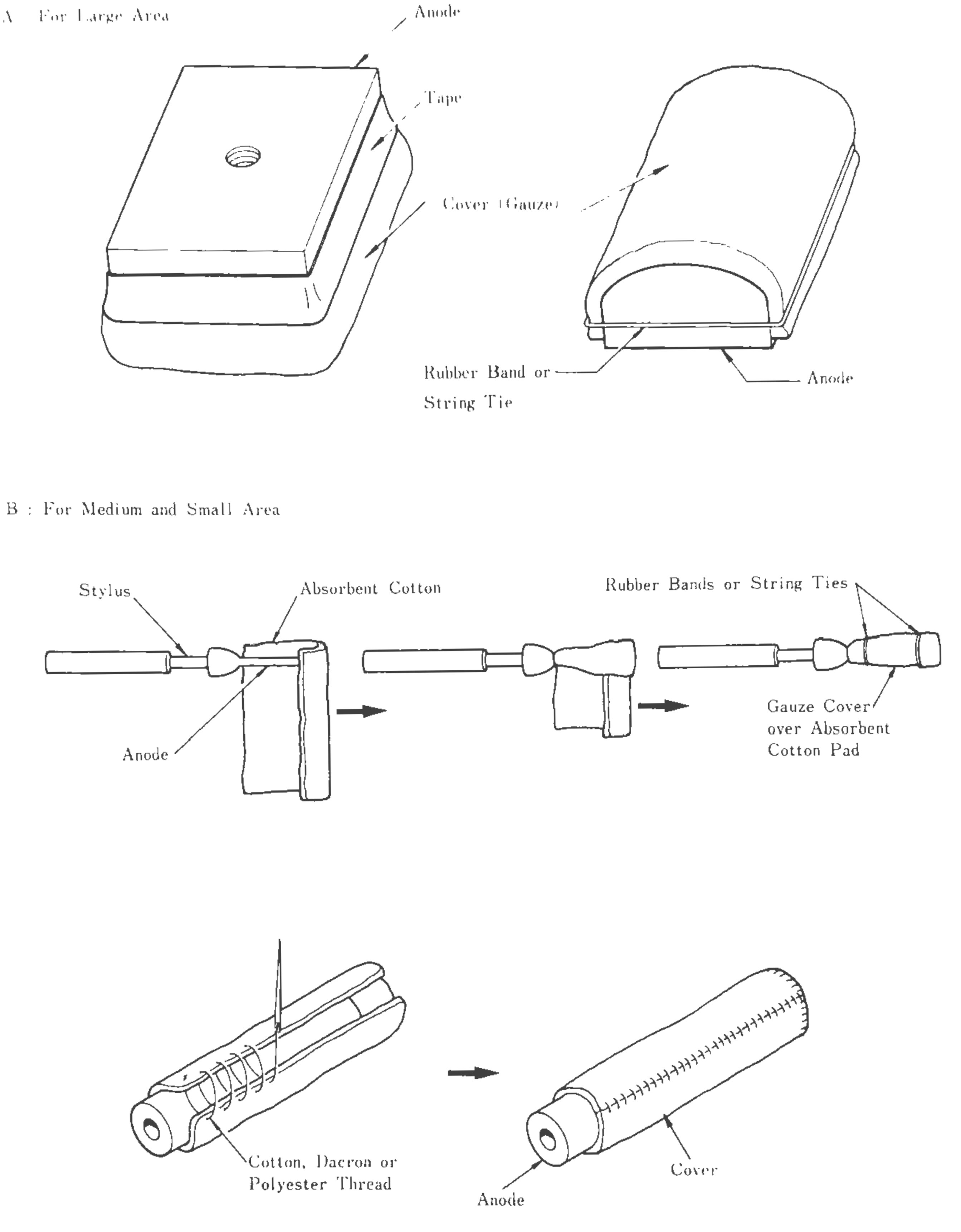
WARNING : Since each used treatment solution includes harmfull components such as acid, alkali, cadmium, chromium, etc., contain it in a suitable container and throw it away through a waste fluid disposal facility. Also, when the cadmium plating solution is mixed with an acid solution, a poisonous gas will be produced, and the danger of serious harm to the human body is present, therefore sufficient care must be taken throughout the procedure in order to prevent such an event.

(4) The voltage to be applied is generally shown on the container of treatment solution, but since it varies with size of anode, operating speed, retained quantity of treatment solution, etc., , rehearsal shall be performed, and good plating conditions must be established before applying them to actual parts of an airplane.



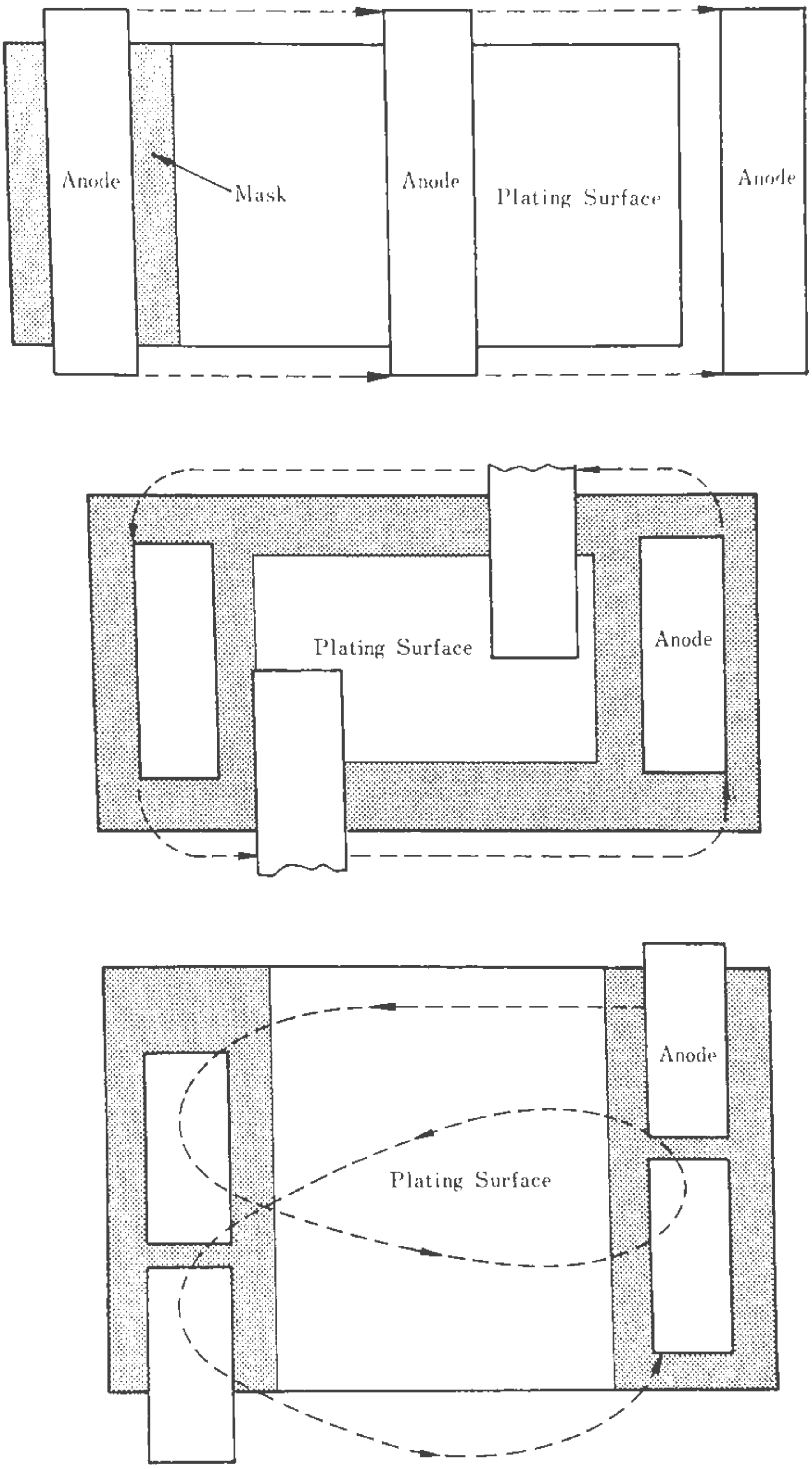
Brush Plating Devices

Figure 1



Methods for Securing Anode Covers

Figure 2



Typical Anode Movements Across Plating Surface and Masks

Figure 3

3. Repair

A. Brash plating to repair cadmium plated portions which have scratches or corrosion.

(1) Remove scratches and corrosion with a scraper or abrasive paper (over #150, processing surface over #500 for finishing) as shown in Figure 4, and confirm that the reduction in thickness due to the removal does not exceed the allowable limit value.

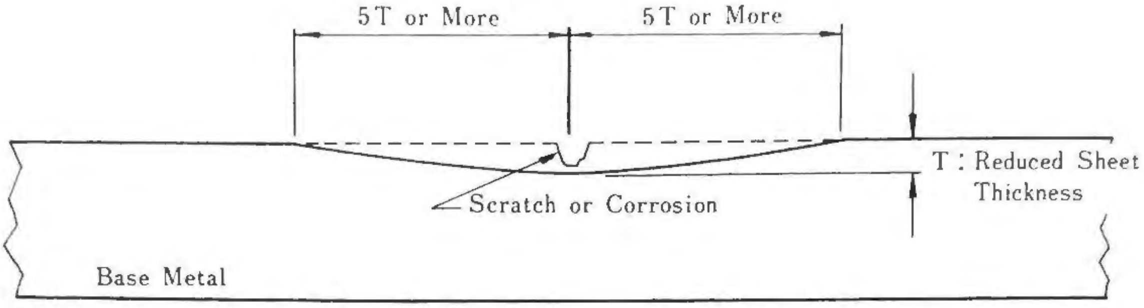


Figure 4

(2) With suitable masking material such as polyethylene sheet, protect the periphery where solvent or drug used for brush plating should not adhere or enter.

(3) Wash and clean the applied portion and its periphery with trichloroethylene or 1.1.1. trichloroethane. (See paragraph 20-10-1.)

(4) Mask with suitable masking material except for the applied portion. (See Figure 5.)

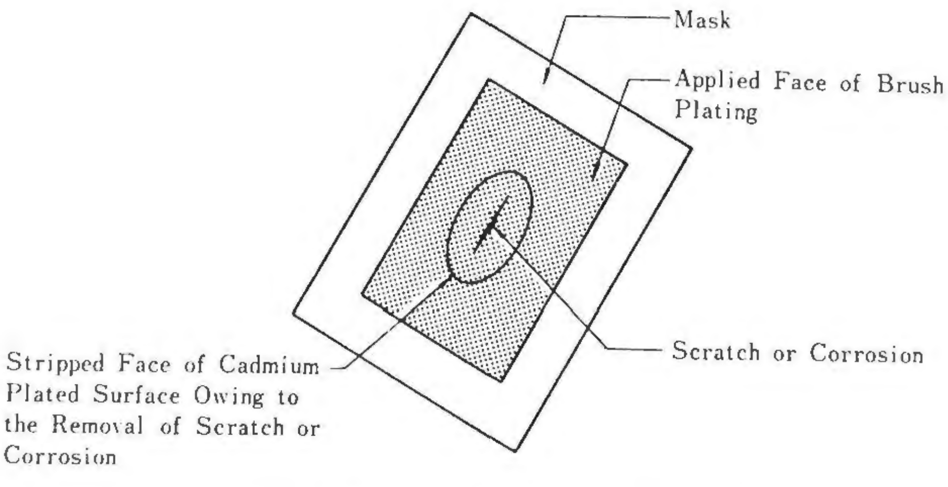


Figure 5 Protection for Cadmium Plated Face

(5) Polish the applied portion with clean water and 3M Scotchbrite (very fine).

(6) After washing with water, perform plating at once under the following conditions.

Solution : Selectron SPS 5070

Conditions : temperature: room temperature
voltage : 4 to 20V
Plating time: until necessary thickness of plating is obtained.

After the above, wash with clean water.

(7) Perform the following treatment after plating. (See paragraph 20-42-4, 6, B.)

(a) When type I (without chromate treatment) is required.

Solution : chromic anhydride ..... 60 to 75 g/ℓ

Conditions : After keeping in a humid condition at room temperature for 5 to 15 seconds, then dry.

NOTE : Unless special difficulties exist, perform type II treatment to prevent occurrence of discoloration or corrosion.

(b) When type II (with chromate treatment) is required, and especially when the type is not specified.

Solution : Iridite #3A 1 volume
Iridite #3B 1 volume
water 10 volumes
} mixed solution by the volume ratio.

Conditions : after applying in solution at room temperature for 10 to 30 seconds, wash with clean water, and dry in atmosphere below 50°C.

B. Process for applying brush plating to portions where immersion plating is difficult.

(1) General

When the plated thickness is partially thin, or unplated parts are left because the shape of an applied part is complicated to apply the immersion plating process (cyanide process) in paragraph 20-42-4, the following process is applicable.

NOTE: 1) This brush plating process should be continued next to washing process with water after the immersion plating has finished.

2) Parts should be handled wearing clean rubber gloves and the like in order to keep safety of workers and to prevent parts from contamination.

(2) Procedures

a) Polish and clean faces to be plated and their periphery with new (or exclusive) 3M Scotchbrite (very fine).

b) Perform cadmium plating according to paragraph 3.A.(6) after cleaning with water.

c) Perform each treatment according to paragraph 3.A. (7).

C. Process for applying cadmium brush plating newly to steel materials

(1) With suitable masking material such as polyethylene sheet, protect portions where solvent or drug used for brush plating should not adhere or enter.

(2) Wash and clean the area inside the mask with suitable solvent such as trichloroethylene.

(3) Polish and clean the applied face with alumina abrasive or abrasive paper more than #400 (more than #500 for finishing), or with 3M Scotchbrite (very fine).

(4) Partition the applied face with suitable masking material, and assure that the peripheral parts are protected from solvent scatter and enter.

(5) Anode-electrolize with Selectron alkali cleaner (#SCN-410) from 4 to 20V at room temperature until water repellent phenomenon disappears on the applied surface. Necessary time for this will be less than about one minute. If it is necessary to apply the above process for more than one minute to have the water repellant phenomenon disappear, perform solvent washing or reduce the applied area.

(6) Wash with clean water.

(7) Perform anodic etching with Selectron activator #2 at room temperature from 4 to 15V. Necessary time is less than about 30 seconds. If the applied portion is high carbon steel and occurrence of smut is observed, perform at above etching (removal of smut) with Selectron activator #3.

(8) Wash with clean water.

(9) When the material of a part to be plated is anticorrosive or heat-resistant steel, perform the following nickel strike plating. When it is other than anticorrosive or heat resisting steel, perform cadmium plating directly.

Solvent : Selectron SPS 563

Conditions : temperature: room temperature
voltage : 4 to 30V
plating time : 3 to 5 minutes

(10) Wash with clean water, and move on to cadmium plating directly.

(11) Perform cadmium plating and the subsequent process according to paragraph 3.A. (6) and the subsequent.

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53-L.E.P.	*1	Sep 30/86	53-40-3	*701	Sep 30/86
	2	Jul 25/74		702	BLANK
53-T.O.C.	1	Jan 31/68		*801	Sep 30/86
	2	BLANK		802	BLANK
53-40-1	1	Jul 1/69		*901	Sep 30/86
	2	Jul 1/69		902	BLANK
	3	Jul 1/69			
	4	BLANK		*1001	Sep 30/86
				1002	BLANK
53-40-2	1	Jan 31/68			
	2	Jan 31/68		*1101	Sep 30/86
	3	Jan 31/68		*1102	Sep 30/86
	4	Jan 31/68		*1103	Sep 30/86
	5	Jan 31/68		1104	BLANK
	6	Jan 31/68			
	7	Mar 10/77	53-40-4	1	Nov 20/71
	8	BLANK		2	BLANK
53-40-3	*1	Sep 30/86		101	Nov 20/71
	2	BLANK		102	BLANK
	*101	Sep 30/86		201	Nov 20/71
	102	BLANK		202	BLANK
	*201	Sep 30/86		301	Nov 20/71
	202	BLANK		302	BLANK
	*301	Sep 30/86		401	Nov 20/71
	302	BLANK		402	Nov 20/71
	*401	Sep 30/86		501	Nov 20/71
	*402	Sep 30/86		502	BLANK
	*403	Sep 30/86			
	404	BLANK		601	Nov 20/71
				602	Nov 20/71
	*501	Sep 30/86		603	Nov 20/71
	502	BLANK		604	Nov 20/71
	*601	Sep 30/86		701	Nov 20/71
	602	Nov 20/71		702	BLANK
	603	Nov 20/71			
	604	Nov 20/71		801	Nov 20/71
				802	BLANK

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53-40-4	901	Nov 20/71			
	902	BLANK			
	1001	Nov 20/71			
	1002	BLANK			
	1101	Nov 20/71			
	1102	Nov 20/71			
	1103	Nov 20/71			
	1104	BLANK			

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FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO.01-38101-11/-12/-31/-32, 01-38106-11/-13

DESCRIPTION AND OPERATION

1. Description

The fitting comprises the four fittings on the fuselage side for installation of the vertical stabilizer, the two forward side fittings being installed on the aft fuselage circular frame with four bolts respectively and the two aft side fittings being installed on the aft fuselage circular frame with four bolts and ten rivets respectively.
The forward fittings are consisted of an aluminum alloy forging and a bushing respectively and the aft fittings are aluminum alloy forgings.
The aft fittings for airplanes prior to #28 however, are provided with a bushing in the vertical stabilizer mounting hole.

2. Operation

These fittings are the fuselage side hardwares to fix the vertical stabilizer.

3. Leading Particulars

Fwd Fittings:
External Dimensions: Approx. 120 mm x 180 mm x 120 mm (4.7" x 7.1" x 4.7")
Weight: Approx. 1.7 kg (3.7 lbs.)

Aft Fittings:
External Dimensions: Approx. 70 mm x 80 mm x 290 mm (2.8" x 3.1" x 11.4")
Weight: Approx. 1.6 kg (3.5 lbs.)

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/32, 01-38106-11/-13

DISASSEMBLY

1. Disassembly (see Figure 1101)

   A. Remove the vertical stabilizer and the rudder according to paragraph 55-30-1,1.

   B. Remove the upper bolts (8) of the fittings (01-38102-3, 01-38103-3, 01-38104-3, 01-38105-3) for installation of the vertical stabilizer on the F. STA. 8554 aft fuselage circular frame.

   C. Remove the attaching bolts (11) of the forward fittings (01-38101-11, -31/-12, -32), and remove the fittings.

   Note: 1) When removing the fittings under the condition that the vertical stabilizer and the rudder are installed, hang the stabilizer with the sling (01-96601), draw out the fittings one side by one side and remove them.
   Since the inside bolts cannot be pulled out because they come in contact with the member of the stabilizer, loose the bolts and remove them together with the fittings.

   2) Since the aft side fittings (01-38106-11/-13) are installed with four bolts and ten rivets, they are not removed.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

CLEANING

1. Remove the paint with paint remover (MIL-R-25134).

   CAUTION: MASK THE AIRFRAME SURFACE SURROUNDING THE FITTING AND BE CAREFULL NOT TO APPLY THE PAINT REMOVER TO THE AREAS OTHER THAN THE FITTING.

2. Clean with cleaning solvent (P-D-680).

   WARNING: WHILE USING THE SOLVENT, PROVIDE GOOD VENTILATION. DO NOT INHALE RICH SOLVENT VAPOR OR SMEAR THE SKIN WITH THE SOLVENT. KEEP THE SOLVENT AWAY FROM FIRE.

3. After cleaning, dry with a lint-free cloth or with dry compressed air of max. 1.4 kg/mm2 (20 psi) pressure.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

INSPECTION/CHECK

1. Visually inspect all the parts, for dents, cracks, recessions, scratches, corrosion as well as indication of wear.

2. Perform dye-check (MIL-I-6866) with regard to all the parts.

3. Check the dimensions at A, C, and E of Figure 601, whether they meet the requirements specified in Table 601.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

REPAIR

1. Repair

   A. Polish out small damages (nicks and scratches) and slight corrosion on the surface. Use grade #600 to 800 aluminum-oxide abrasive cloth (P-L-451) for the aluminum alloy main body.

   B. Replace with a new bushing when red or black rust and separation of plating are found on the end face of the bushing.

   C. Remove deep corrosion on the surface of the lug of the fitting in accordance with STRUCTURAL REPAIR MANUAL 53-8-2.

2. Refinish

   A. Touch up the polished surface of aluminum alloy main body with Alodine (MIL-C-5541).

   B. Apply one coat of wash primer (MIL-C-8514) and two coats of zinc-chromate primer (MIL-P-8585) on the surface of the fittings (01-38106-11/-13). Apply one coat of epoxy primer (MIL-P-23377) and two coats of epoxy enamel (MIL-C-22750) on the surface of the forward fittings (01-38101-11,-31/-12,-32).

   C. Apply fillet seal (PR1422 Class A or equivalent) on the end face of the steel bushings (2) and (4).

3. Replacement

   A. Replace all the parts which do not pass the dye-check inspection (MIL-I-6866).

   B. Replace the bushings which do not meet the dimensional requirements specified by A and C of Table 601 with regard to A and C of Figure 601.

   C. When replacement of the bushings is required, press the old bushings (2), (4) and (6) [or (2A), (4A) and (6A), or (2B), (4B) and (6B)] out of the fittings (1), (3) and (5), and measure the I.D. of fittings. Then, depending upon the result of measuring, replace the bushings by either of the following procedures.

(1) When the I.D. of fittings meets the requirements of B and D of Table 601, apply a thin coat of wet seal (PR1422 Class A or equivalent) to the bushing (2) and (4) and the fitting (1) and (3), and wet zinc-chromate primer (MIL-P-8585) to the bushing (6) and the fitting (5) over the external surface of the new bushings (2), (4) and (6) and the applicable surface of fittings (1), (3) and (5), and press the bushings into the fittings.
After pressing the bushings (2) and (4) into the fittings (1) and (3), line-ream the inner diameter of bushings to meet the I.D. requirements of A of Table 601.

(2) When the I.D. of fittings exceeds the allowable values of B and D of Table 601, rework the I.D. of fittings to the dimensions specified by B_1 and D_1 of Table 601, and press the new bushings (2A), (4A) and (6A) for salvaging into the fittings (1), (3) and (5), after applying a thin coat of wet seal (PR1422 Class A or equivalent) to the bushing (2A) and (4A) and the fitting (1) and (3), and wet zinc-chromate primer (MIL-P-8585) to the bushing (6A) and the fitting (5) over the external surface of bushings and the applicable surface of fittings.
After pressing the bushings (2A) and (4A) into the fittings (1) and (3), line-ream the inner diameter of bushings to meet the I.D. requirements of A of Table 601.

(3) When the I.D. of fittings meets the requirements of B_1 and D_1 of Table 601, press the new bushings (2A), (4A) and (6A) for salvaging into the fittings (1), (3) and (5) after applying a thin coat of wet seal (PR1422 Class A or equivalent) to the bushing (2A) and (4A) and the fitting (1) and (3), and wet zinc-chromate primer (MIL-P-8585) to the bushing (6A) and the fitting (5) over the external surface of bushings and the applicable surface of fittings.
After pressing the bushings (2A) and (4A) into the fittings (1) and (3), line-ream the inner diameter of bushings to meet the I.D. requirements of A of Table 601.

(4) When the I.D. of fittings exceeds the allowable values of B_1 and D_1 of Table 601, rework the I.D. of fittings to the dimensions specified by B_2 and D_2 of Table 601, and press the new bushings (2B), (4B) and (6B) for salvaging into the fittings (1), (3) and (5), after applying a thin coat of wet seal (PR1422 Class A or equivalent) to the bushing (2B) and (4B) and the fitting (1) and (3), and wet zinc-chromate primer (MIL-P-8585) to the bushing (6B) and the fitting (5) over the external surface of bushings and the applicable surface of fittings.
After pressing the bushings (2B) and (4B) into the fittings (1) and (3), line-ream the inner diameter of bushings to meet the I.D. requirements of A of Table 601.

(5) When the I.D. of fittings meets the requiremensts of B_2 and D_2 of Table 601, press the new bushings (2B), (4B) and (6B) for salvaging into the fittings (1), (3) and (5), after applying a thin coat of wet seal (PR1422 Class A or equivalent) to the bushing (2B) and (4B) and the fitting (1) and (3), and wet zinc-chromate primer (MIL-P-8585) to the bushing (6B) and the fitting (5) over the external surface of bushings and the applicable surface of fittings.
After pressing the bushings (2B) and (4B) into the fittings (1) and (3), line-ream the inner diameter of bushings to meet the I.D. requirements of A of Table 601.

(6) When the I.D. of fittings exceeds the allowable values of B_2 and D_2 of Table 601, replace the fitting assembles in their entirety.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

ASSEMBLY

1. Assembly

   A. Apply a coat of sealing compound PR1436G (MIL-S-81733) or PR1422 Class A (MIL-S-8802) or equivalent to the grip face of the bolts (11), and insert them to the forward fittings (01-38101-11,-12,-31,-32).

   B. Install the forward fittings (01-38101-11,-12,-31,-32) to the attachment fittings (15), (16), (17), and (18) of the vertical stabilizer on the F. STA. 8554 frame, and tighten the nuts (10) to 1300-2160 in-lb torque to prevent the bolts (8) from turning. Paint slip marks on the nuts.

   C. Apply a coat of sealing compound PR1321 class A (MIL-S-8784) to the heads of the bolts (11).

   D. Install the bolts (11). Tighten the nuts to the standard torque, and paint slip marks to the nuts.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

FITS AND CLEARANCES

Comply with Figure 601 and Table 601.

Table 601 Fits and Clearances

Ref. Letter Fig. 601	Mating Index No. Fig. 1101		Original Design Limits				Service Wear Limits		
			Dimensions mm (inch)		Assembly Clearance mm (inch)		Dimension Limits mm (inch)		Maximum Allowable Clearance mm (inch)
			Min.	Max.	Min.	Max.			
A	ID	2.4	22.205 (0.8742)	22.230 (0.8752)	0.025 (0.0010)	0.076 (0.0030)	—	22.240 (0.8756)	0.086 (0.0034)
	OD	—	22.154 (0.8722)	22.179 (0.8732)					
B	ID	1.3	26.987 (1.0625)	27.013 (1.0635)	Fit Tight 0.051 (0.0020)	Fit Tight 0.102 (0.0040)		27.039 (1.0645)	Fit Tight 0.025 (0.0010)
	OD	2.4	27.0637 (1.0655)	27.0891 (1.0665)			27.039 (1.0645)		
B_1	ID	1.3	27.987 (1.1019)	28.013 (1.1029)	Fit Tight 0.051 (0.0020)	Fit Tight 0.102 (0.0040)		28.039 (1.1039)	Fit Tight 0.025 (0.0010)
	OD	2A, 4A	28.064 (1.1049)	28.089 (1.1059)			28.039 (1.1039)		
B_2	ID	1.3	28.987 (1.1412)	29.013 (1.1422)	Fit Tight 0.051 (0.0020)	Fit Tight 0.102 (0.0040)		29.039 (1.1432)	Fit Tight 0.025 (0.0010)
	OD	2B, 4B	29.064 (1.1442)	29.089 (1.1452)			29.039 (1.1432)		
C	ID	6	25.50 (1.004)	25.65 (1.010)	3.31 (0.130)	3.53 (0.139)	—	25.65 (1.010)	3.53 (0.139)
	OD	—	22.116 (0.8707)	22.192 (0.8737)					

FITTING ASSEMBLY VERTICAL STABILIZER
PART NO. [illegible]

TESTING

Not applicable.

FITTING ASSEMBY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

TROUBLE SHOOTING

Not applicable.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

STORAGE INSTRUCTION

Not applicable.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

SPECIAL TOOLS, FIXTURE AND EQUIPMENTS

Not applicable.

FITTING ASSEMBLY-VERTICAL STABILIZER
PART NO. 01-38101-11/-12/-31/-32, 01-38106-11/-13

ILLUSTRATED PARTS LIST

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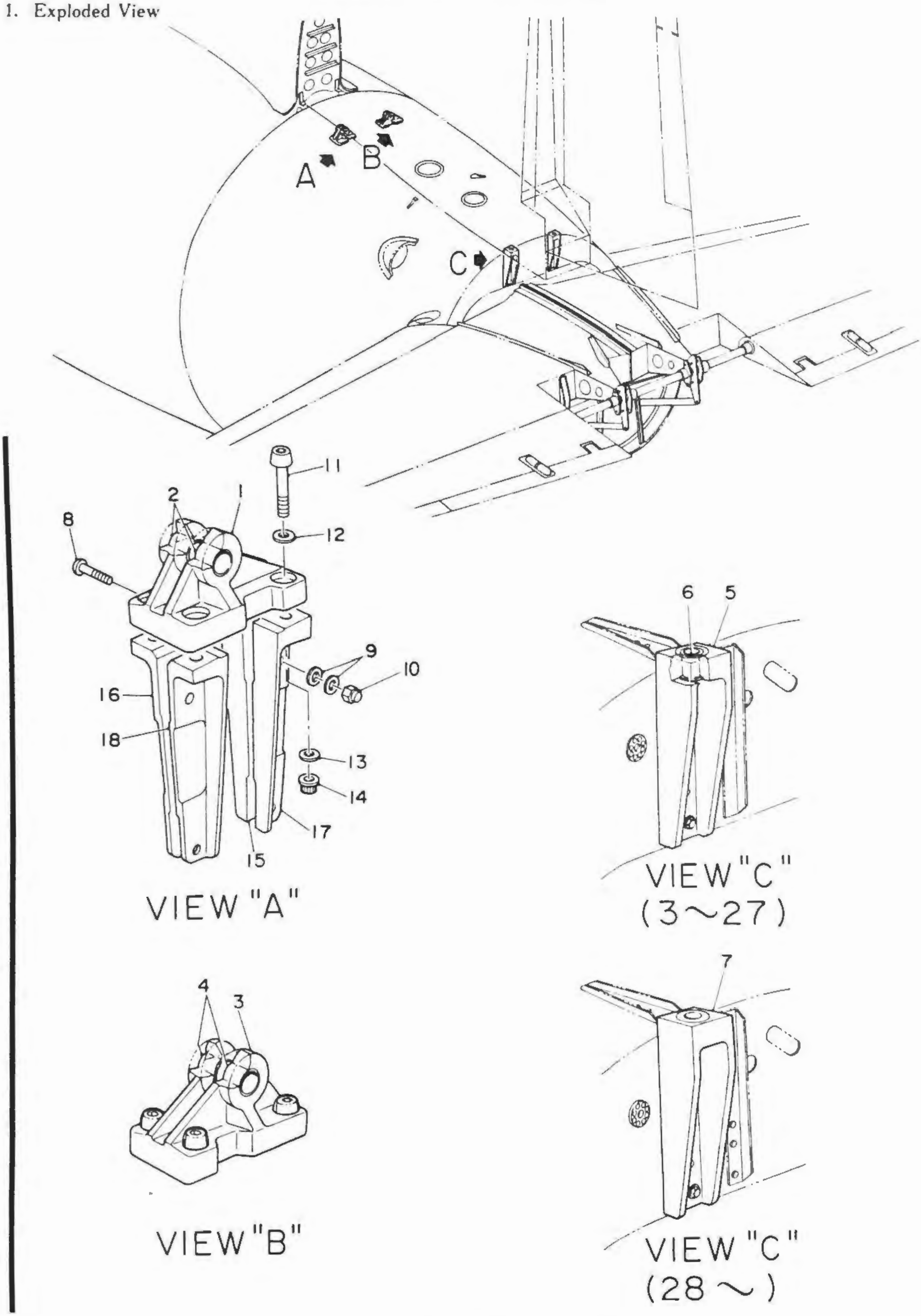
1. Exploded View



Fitting–Vertical Stabilizer

Figure 1101

2. Group Assembly Parts List

	FIGURE & INDEX NO.	PART NUMBER	NOMENCLATURE 1 2 3 4 5 6 7	UNIT PER ASSY	USE ON CODE	NOTE
	1101-		FITTING-VERTICAL STABILIZER			
	-	01-38101-11	. FITTING ASSY-UPPER,FRONT SPAR,VERTICAL STABILIZER(LH)	1		
R	-	01-38101-31	. FITTING ASSY-UPPER,FRONT SPAR,VERTICAL STABILIZER(LH)	1		
	-1	01-38101-3	. . FITTING	1		NS
R	-1A	01-38101-33	. . FITTING	1		
	-2	01-38101-5	. . BUSHING	2		
	-2A	01-38101-15	. . BUSHING (FOR SALVAGE 1.0mm SIZE Up)	2		
	-2B	01-38101-17	. . BUSHING (FOR SALVAGE 2.0mm SIZE Up)	2		
	-	01-38101-12	. FITTING ASSY-UPPER,FRONT SPAR,VERTICAL STABILIZER(RH)	1		
R	-	01-38101-32	. FITTING ASSY-UPPER,FRONT SPAR,VERTICAL STABILIZER(RH)	1		
	-3	01-38101-4	. . FITTING	1		NS
R	-3A	01-38101-34	. . FITTING	1		
	-4	01-38101-5	. . BUSHING	2		
	-4A	01-38101-15	. . BUSHING (FOR SALVAGE 1.0mm SIZE Up)	2		
	-4B	01-38101-17	. . BUSHING (FOR SALVAGE 2.0mm SIZE Up)	2		
	-	01-38106-11	. FITTING ASSY-AFT. SPAR VERTICAL STABILIZER	2	#3~#27	
	-5	01-38106-3	. . FITTING	1	#3~#27	NS
	-6	01-38106-5	. . BUSHING	1	#3~#27	
	-6A	01-38106-25	. . BUSHING (FOR SALVAGE 0.5mm SIZE Up)	1	#3~#27	
	-6B	01-38106-27	. . BUSHING (FOR SALVAGE 1.0mm SIZE Up)	1	#3~#27	
	-7	01-38106-13	. FITTING-AFT SPAR VERTICAL STABILIZER	2	#28~	
	-8	NAS336CPA-15	. BOLT-UPPER	4		
	-9	AN960-616L	. WASHER	8		
	-10	MS20365-624	. NUT	4		
	-11	MS20002-12	. BOLT-ATTACHEMENT	8		
	-12	MS20002C10	. WASHER	8		
	-13	MS20002-10	. WASHER	8		
	-14	42FW-1018	. NUT	8		
	-15	01-38102-3	. FITTING-FRONT SPAR ATTACHEMENT	2		
	-16	01-38103-3	. FITTING-FRONT SPAR ATTACHEMENT	2		
	-17	01-38104-3	. FITTING-FRONT SPAR ATTACHEMENT	2		
	-18	01-38105-3	. FITTING-FRONT SPAR ATTACHEMENT	2		

NS : NOT SUPPLIED PART

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	*2	Sep 30/86		614	Jun 30/75
	3	Mar 10/77		701	Jun 30/75
	4	BLANK		702	BLANK
55-T.O.C.	i	Sep 18/75		801	Jun 30/75
	ii	BLANK		802	BLANK
55-10-1	1	Jan 31/68		901	Jun 30/75
	2	Jan 31/68		902	BLANK
	3	Jan 31/68		1001	Jun 30/75
	4	Jan 31/68		1002	BLANK
	5	Jan 31/68		1101	Jun 30/75
	6	BLANK		1102	Jun 30/75
55-20-1	1	Jun 30/75		1103	Jun 30/75
	2	BLANK		1104	Jun 30/75
				1105	Jun 30/75
	101	Jun 30/75		1106	Jun 30/75
	102	Jun 30/75		1107	Jun 30/75
				1108	Jun 30/75
	201	Jun 30/75		1109	Jun 30/75
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	401	Sep 18/75		1115	Jun 30/75
	402	Jun 30/75		1116	Jun 30/75
				1117	Jun 30/75
	501	Jun 30/75		1118	Jun 30/75
	502	Jun 30/75		1119	Jun 30/75
				1120	Jun 30/75
	601	Jun 30/75		1121	Jun 30/75
	602	Jun 30/75		1122	Mar 10/77
	603	Jun 30/75		1123	Mar 10/77
	604	Jun 30/75		1124	Mar 10/77
	605	Jun 30/75		1125	Mar 10/77
	606	Jun 30/75		1126	Mar 10/77
	607	Jun 30/75		1127	Mar 10/77
	608	Jun 30/75		1128	BLANK
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	610	Jun 30/75		2	Deleted
	611	Jun 30/75		3	Deleted
	612	Jun 30/75		4	BLANK

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	*3	Sep 30/86		615	Sep 18/75
	*4	Sep 30/86		616	Sep 18/75
	*5	Sep 30/86		617	Sep 18/75
	*6	Sep 30/86		618	Sep 18/75
	*7	Sep 30/86		619	Sep 18/75
	*8	Sep 30/86		620	Sep 18/75
				621	Sep 18/75
55-40-1	1	Sep 18/75		622	Sep 18/75
	2	BLANK		623	Sep 18/75
				624	Sep 18/75
	101	Sep 18/75		625	Sep 18/75
	102	Sep 18/75		626	Sep 18/75
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	201	Sep 18/75		628	BLANK
	202	BLANK			
				701	Sep 18/75
	301	Sep 18/75		702	BLANK
	302	Sep 18/75			
	303	Sep 18/75		801	Sep 18/75
	304	BLANK		802	BLANK
	401	Sep 18/75		901	Sep 18/75
	402	Sep 18/75		902	BLANK
	501	Sep 18/75		1001	Sep 18/75
	502	Sep 18/75		1002	BLANK
	503	Sep 18/75			
	504	BLANK		1101	Sep 18/75
				1102	Sep 18/75
	601	Sep 18/75		1103	Mar 10/77
	602	Sep 18/75		1104	Sep 18/75
	603	Sep 18/75		1105	Sep 18/75
	604	Sep 18/75		1106	Sep 18/75
	605	Sep 18/75		1107	Mar 10/77
	606	Sep 18/75		1108	Sep 18/75
	607	Sep 18/75		1109	Sep 18/75
	608	Sep 18/75		1110	Sep 18/75
	609	Sep 18/75		1111	Sep 18/75
	610	Sep 18/75		1112	Sep 18/75
	611	Sep 18/75		1113	Sep 18/75
	612	Sep 18/75		1114	Sep 18/75
				1115	Sep 18/75
				1116	Sep 18/75

*The asterisk indicates pages revised or added by the current revision.

FITTING - VIRTICAL STABILIZER

1. Disassembly (See Figure 1.)

A. Place the work stand properly.

B. Remove the tail cone (01-38400).

C. Remove the fillet (01-38301).

D. Remove the upper cover (01-38501).

E. Remove the dorsal fin cover (01-34280-15).

F. Disconnect the rudder control cable at the turnbuckle in the after fuselage, and fix the cable at the pulley with a clump to avoid slack of the cable.

G. Remove the rudder (01-23001-301).

CAUTION: IN CASE THE VIRTICAL STABILIZER IS TO BE REMOVED WITH THE RUDDER INSTALLED, THE PROCEDURES DESCRIBED BELOW SHALL BE FOLLOWED INSTEAD OF STEPS F AND G.

(1) Fix the trim tab control cable at the actuator dram with a clamp.

(2) After fastening the quadrant with installation, disconnect the control cable from the rudder tension regulator.

(3) Fix the cable disconnected in Step (2) above at the pulley in the after fuselage to avoid slack.

H. Remove all access doors.

J. Disconnect the electric harness of the VOR antenna at the connector in the after fuselage.

K. Disconnect the bonding jumper between the root rib and the fuselage.

L. Disconnect the de-icer duct near the rudder root rib.

M. Disconnect the electric wiring of the de-icer at the lower part of the leading edge.

N. Hang the stabilizer with the sling (01-96001).

P. Remove bolt (11), washers (12), (13) and (14), and nut (15) attaching the rear spar.

Q. Remove taper bolt (3), sleeve (4), washers (5), (6) and (7), and nut (8) attaching the front spar.

R. Pull up the rudder slowly.

2. Inspection (see Figure 1)

   A. Visually inspect all the parts for dents, cracks, depressions, scratches, corrorsion as well as indication of wear.

   B. Check the attaching parts of the front spar fitting (1) and (2) for cracks by magnaflux inspection.

   C. Check the attaching parts of the rear spar fitting (9) and (10) for cracks by magnaflux inspection.

3. Repair

   A. Polish out small damages (nicks and scratches) and slight corrorsion on the surface, and use crocus cloth (P-C-458) or grade #600 to 800 aluminum-oxide abrasive cloth (P-L-451).

      Note: When deep corrorsion exists, remove it depending on the concrete examples for repair in STRUCTURAL REPAIR MANUAL55-7-2.

   B. Touch up the polished surface with Alodine (MIL-C-5541).

   C. Apply one coat of epoxy primer (MIL-P-23377), and two coats of epoxy enamel (MIL-C-22750) on the surface of the front spar fittings (1) and (2).

4. Fits and Clearances

   The fits and clearances shall be in accordance with Table 1.

5. Assembly (See Figure 1)

Installation is accomplished in the reversed order of the removal sequence.

Note 1: Install the taper bolt (3) and sleeve (4) shown in View A without play. The tightening torque of the front spar attaching nut (8) shall be 250 to 350 in-lb.

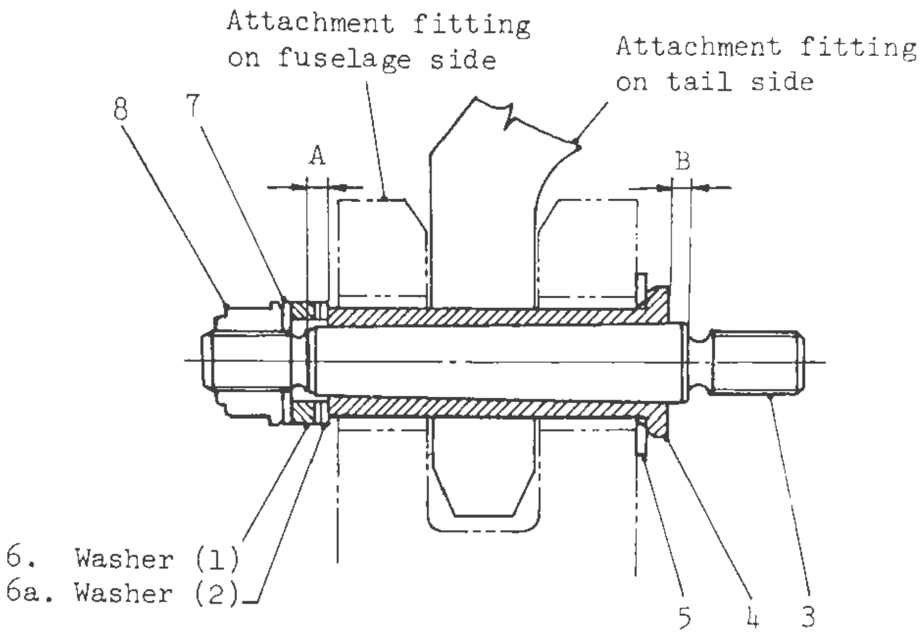

Figure 1

	#1, 2	#3～#35	#36～
Protrusion A	0～1.21	2.6～5.6 (REF)	0.6～7.6
Protrusion B	-	5.0～1.5	2.0～9.0
Taper bolt	01-20906-1	01-20906-11	01-20906-21
Washer (1)	01-20908-1	01-20908-1	01-20908-3,-5,-7
Washer (2)	-	MS20002-12(#28～) Use the washer (2) as necessary during installation	MS20002-12 Use the most adequate washer (1) depending on the protrusion. Use the washer (2) as necessary but the number shall not exceed 2.

NOTE 2: Replace the washers (14), (14a) or (14b) for the rear spar attaching fittings shown in View B with new parts without fail. Determine the thickness of washers when they are installed in accordance with the following instructions:

(a) Place the washer (14) on the attaching fitting on the fuselage side. (Bolt tightening torque: 0)

(b) Measure the clearance "t" between the washer and the attaching fitting (9) on the tail side.